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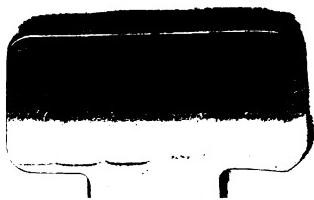
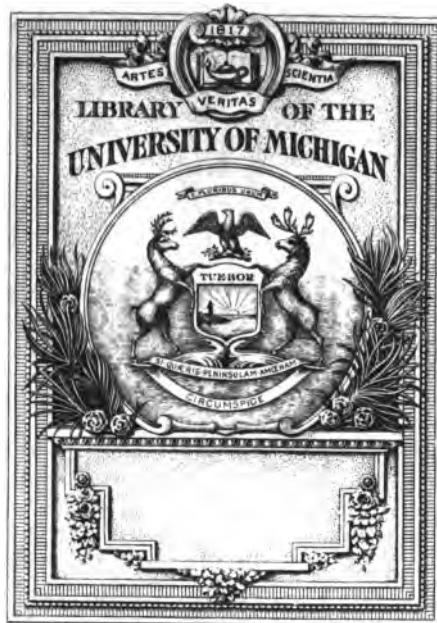
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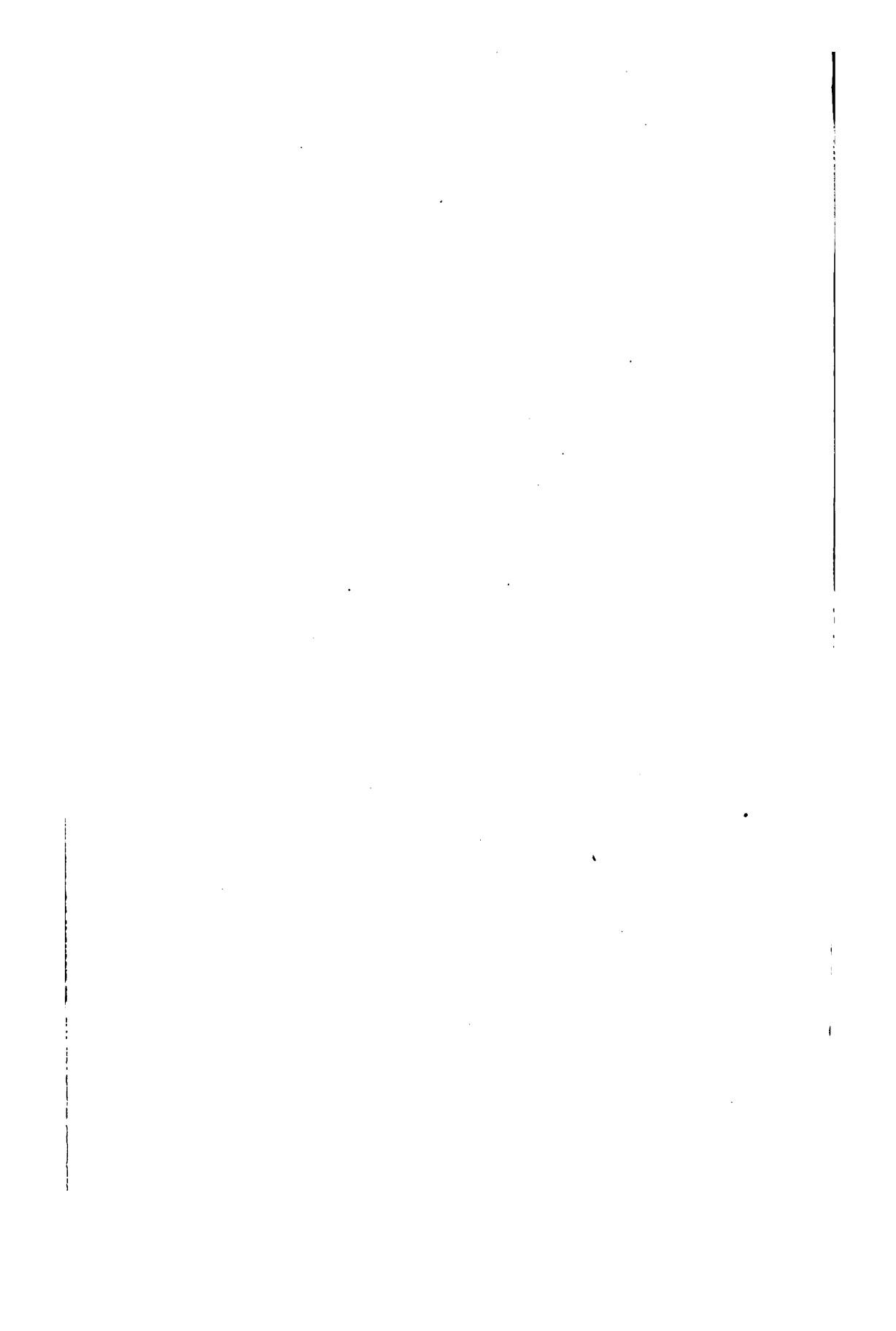
METROPOLITAN WATER
AND SEWERAGE BOARD

FIFTEENTH ANNUAL REPORT

DECEMBER 31, 1915.



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FIFTEENTH ANNUAL REPORT

Massachusetts
OF THE
METROPOLITAN WATER AND
SEWERAGE BOARD.

FOR THE YEAR 1915.



BOSTON:
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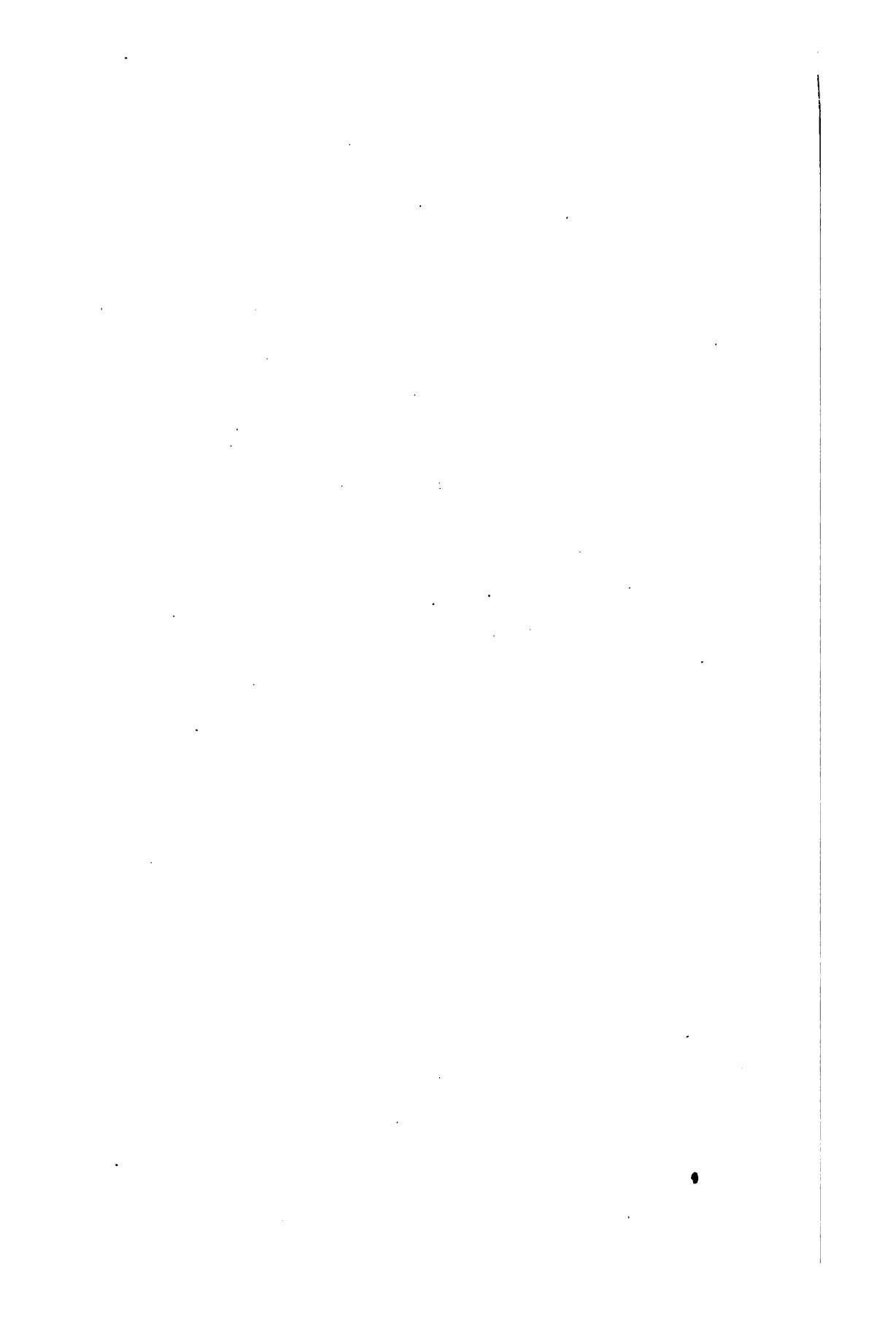
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METROPOLITAN WATER AND SEWERAGE BOARD.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan Water and Sewerage Board, established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its receipts, expenditures, disbursements, assets and liabilities for the fiscal year ending on November 30, 1915, and now, in accordance with the provisions of chapter 235 of the Acts of the year 1906, presents a detailed statement of its doings for the calendar year ending on December 31, 1915, being its

FIFTEENTH ANNUAL REPORT.

I. ORGANIZATION AND ADMINISTRATION.

BOARD, OFFICERS AND EMPLOYEES.

The term of office of Thomas E. Dwyer expired on March 20, and he was reappointed for the term of three years next succeeding. At the end of the year the Board consisted of Henry P. Walcott, chairman, Edward A. McLaughlin and Thomas E. Dwyer. William N. Davenport has continued as secretary. Alfred F. Bridgman has been the purchasing agent and Miss Alice G. Mason the bookkeeper.

There are also employed in the administrative office a paymaster, an assistant in auditing, two general clerks, three stenographers and clerks, a telephone operator, and a janitor with two assistants, both of whom act as watchmen.

Such general conveyancing work and investigation of real estate titles in the different counties as have been called for during the year have been performed by George D. Bigelow.

The consulting engineers of the Board are Hiram F. Mills and Frederic P. Stearns, who are called upon for services when matters arise which require their consideration.

Dexter Brackett, Chief Engineer of Water Works, died on August 26, 1915, and the Board makes this record of its appreciation:— In the death of Mr. Brackett the Board feels that the Commonwealth has lost a tried and faithful public servant, who has rendered most important service in the construction and maintenance of the Metropolitan Water Works. Mr. Brackett had been connected with the Water Department of the City of Boston for many years prior to the creation of the Metropolitan Water Board in 1895. Upon the organization of that Board he was appointed Engineer of the Distribution Department, which position he held during the existence of the Board. Upon the abolition of the above named Board and the creation of the Metropolitan Water and Sewerage Board in 1901 he was reappointed Engineer of the Distribution Department and continued to serve in that capacity until February 1, 1907, when he was promoted to the position of Chief Engineer of Water Works. During his connection with the Metropolitan Water Works he was in charge of the construction of the Distribution System and considerable portions of the Wachusett and Sudbury systems. Wise forethought, faithful devotion, careful and painstaking management in the execution of the duties entrusted to him have characterized the performance of all his work during his service of more than twenty years.

Since Mr. Brackett's death William E. Foss has been Acting Chief Engineer of Water Works. The following have also continued as superintendents of departments under the direction of the Acting Chief Engineer: Elliot R. B. Allardice, Superintendent of the Wachusett Department; Charles E. Haberstroh, Superintendent of the Sudbury and Cochituate Works and of the portion of the Weston Aqueduct above the Weston Reservoir; Samuel E. Killam, Superintendent in charge of the Weston Reservoir and the remaining portion of the Weston Aqueduct, and of all distributing reservoirs and pipe lines within the Metropolitan Water District; and Arthur E. O'Neil, Superintendent of the several pumping stations.

The average engineering force employed on construction and maintenance during the year has included, in addition to the Acting Chief Engineer, 4 department superintendents, 1 division engineer, 10 assistant engineers and 35 others in various engineering capacities, and as sanitary inspectors, clerks, stenographers and messengers, the total force numbering 51.

A maintenance force in addition to those engaged in engineering

capacities, as above mentioned, numbering upon the average during the year 256, has been required at the pumping stations, upon reservoirs, aqueducts, pipe lines and upon minor construction work. At the end of the year this force numbered 238.

Frederick D. Smith, Engineer of Sewerage Works, has had charge of both construction and maintenance of the works. He has been assisted by Henry T. Stiff, Division Engineer in charge of the office and drafting, by 4 assistant engineers and by 15 others employed in different engineering capacities, and by 2 stenographers and clerks.

The maximum engineering force employed at any one time during the year on the construction and maintenance of the Sewerage Works was 22.

The regular maintenance force required in addition for the operation of the pumping stations, the care and inspection of the sewers, and for other parts of the Sewerage Works, exclusive of the engineers and day-labor forces, on the average has been 167.

The whole regular force of the Sewerage Department at the end of the year numbered 189, of whom the Engineer and 21 assistants and draftsmen were engaged in general upon the works, and of the remainder, 101 were employed upon the North System and 66 upon the South System.

The maximum number of men employed upon contracts and upon day-labor construction on the Sewerage Works during the year was for the week ending November 20, when the number amounted to 340.

II. METROPOLITAN WATER DISTRICT.

The Metropolitan Water District now comprises the cities of Boston, Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy, Revere and Somerville, and the towns of Arlington, Belmont, Lexington, Milton, Nahant, Stoneham, Swampscott, Watertown and Winthrop, — in all 10 cities and 9 towns. The District has an area of 174.8 square miles, no additional municipalities having been admitted into the District during the year. Its population, according to the State Census taken for April 1, 1915, was 1,201,300. The population of the District on July 1, 1915, the date upon which calculations for the Water Works are based, was estimated as 1,207,880.

III. METROPOLITAN WATER WORKS—CONSTRUCTION.

The total amount expended for the construction and acquisition of the Metropolitan Water Works since the passage of the Metropolitan Water Act in the year 1895 has been \$42,818,170.64.

The total amount expended during the calendar year on account of the construction and acquisition of works has been \$404,030.09. The details of this expenditure are as follows: on account of the construction of a steel tank or reservoir on Bellevue Hill with connecting pipe lines and the reinforcement of the southern high-service pipe lines in Milton, the sum of \$77,592.51; for the work on lowering water pipes in Chelsea Creek, \$25,257.67; for work on account of the power plant at Sudbury Dam, \$50,151.16; for laying 60-inch Weston Aqueduct Supply Mains, Section 5, \$223,570.52; for stock on hand, \$21,963.57; and for other minor works, engineering and administration expenses, the sum of \$5,494.66.

The completed work of the year includes the construction of a 42-inch cast-iron water main under Chelsea Creek between Chelsea and East Boston to provide for the deepening of the ship channel by the United States Government. This work was finally completed in the early days of January. Subsequent to the completion of the line the two old pipe lines were removed from the channel and the whole work was finally completed in the last days of February.

The work of laying a second 24-inch cast-iron southern high-service main about 13,000 feet in length from Dorchester Lower Mills through Adams Street in Milton and Quincy to the junction of Adams and Beale streets in Quincy, to reinforce the 24-inch main laid in 1897 and 1898, was finally completed under a contract with John J. Evans of Lawrence. While it was originally planned to connect this new 24-inch pipe line with the Metropolitan Water Works 36-inch main at the junction of Morton and River streets in Dorchester, it was found possible to make a more advantageous connection by purchasing from the City of Boston for \$4,216.62, a portion of the Boston 36-inch main about 461 feet in length. The new 24-inch main was then laid from the junction of River and Washington streets through Washington Street to Sanford Street and connected with the 36-inch main thus purchased.

The steel tank for the southern extra high-service reservoir on Bellevue Hill in West Roxbury, which is 100 feet in diameter and

44 feet 3 inches in height and has a capacity of 2,500,000 gallons, was filled with water and tested for leakage on January 9, with a satisfactory result. On March 25 the tank was taken out of service, drained and painted. The masonry tower which encloses the tank has been built under a contract with John Cashman & Sons Co. The tower is 114 feet 2 inches in outside diameter at the base and 108 feet 2 inches in inside diameter. It is 47½ feet in height from the concrete foundation to the top of the cornice. A parapet wall 4 feet in height above the cornice surrounds the roof. The tower is of Bay View gray Rockport granite backed with concrete, with the exception of that portion of the tower which is below the surface of the ground, which is of concrete.

Work has also been in progress during the year upon the 60-inch Weston Aqueduct supply main which, connecting with that portion laid in 1909 and 1910, extends through Commonwealth Avenue to the Charles River, a distance of about 14,500 feet. The work was divided into two contracts, one with Andrew M. Cusack of Boston, for laying 7,990 linear feet of the pipe line east of Auburn Street, and another with Charles A. Kelley of Somerville, for laying the remainder of the line, with the exception of the crossing under the Boston & Albany Railroad where a 60-inch steel pipe line was laid. Both these contracts were practically finished at the end of the year.

Work has also been in progress during the year for the construction of the hydro-electric plant to utilize the water power available at the Sudbury Dam in Southborough. Substantial difficulties have been experienced in the adaptation of the gate-house at this dam for the purposes of an electric power station but these have all been satisfactorily surmounted, and it is hoped that the production of electric energy for delivery to the Edison Electric Illuminating Company can be begun by the first of April.

IV. WATER WORKS — MAINTENANCE.

The maintenance and operation of the Metropolitan Water Works during the past calendar year have required the expenditure of \$447,659.62.

(1) STORAGE RESERVOIRS.

The water in the Wachusett Reservoir reached its highest elevation, 392.42, on August 25.

The Sudbury Reservoir during the year has been maintained at a

low level in order to facilitate the changes which are being made at the Sudbury Dam for the installation of the electric system. Framingham Reservoir No. 3 and Lake Cochituate have been kept nearly full during the year.

It has not been necessary to draw water for the supply of the Metropolitan District from Framingham Reservoir No. 1, Framingham Reservoir No. 2, Farm Pond, Ashland, Hopkinton and White-hall reservoirs and Lake Cochituate.

(2) AQUEDUCTS.

The Wachusett Aqueduct was in service for the passage of water from the Wachusett Reservoir to the Sudbury Reservoir during the whole or portions of 260 days. The quantity of water flowing through the aqueduct was equal to an average of 70,280,548 gallons per day for the entire year. Of the total quantity of water admitted to the aqueduct 90.2 per cent. was used before its admission for the development of electric energy.

For distribution to the cities and towns of the Metropolitan Water District water was drawn through the Sudbury Aqueduct to the Chestnut Hill Reservoir every day in the year, the daily average for the whole year being 63,261,000 gallons.

The Weston Aqueduct was in use during 349 days, the quantity of water delivered through the aqueduct being equivalent to a daily average of 33,573,000 gallons.

(3) PUMPING STATIONS.

The total amount of water pumped at all the pumping stations was 27,706,300,000 gallons, which is 1,024,860,000 gallons less than in the previous year.

The following are the several pumping stations:—

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Chestnut Hill high-service station,	4	66,000,000	133
Chestnut Hill low-service station,	3	105,000,000	60
Chestnut Hill low-service station,	1	40,000,000	130
Spot Pond station,	2	30,000,000	125
Arlington station,	2	3,000,000	290
Hyde Park station,	2	6,000,000	140

The cost of operating the stations was \$96,847.21, equivalent to \$3.495 per million gallons pumped. The total cost is somewhat less than for the year 1914, the cost per million gallons showing a decrease of \$0.153, the saving being due largely to the smaller amount expended for repairs.

The total amount of coal purchased during the year was 7,361.17 gross tons, of which 5,945.73 tons were bituminous and 1,415.44 tons anthracite. All of the anthracite coal was buckwheat and screenings. The cost of bituminous coal delivered in the bins at the various stations varied from \$3.93 to \$5.06, and the cost of anthracite coal varied from \$2.50 to \$3.08 per ton.

(4) PROTECTION OF THE WATER SUPPLY.

The Marlborough Brook filter-beds, on which is filtered the water received from brooks passing through the thickly settled portions of Marlborough, have been adequate for the filtration of all the water received.

The Pegan Brook pumping station, at which is pumped upon the filter-beds the surface drainage of about one square mile in the thickly settled portion of Natick, was in operation 272 days in the year.

The filter-beds which receive for filtration the water flowing through the thickly settled portion of the town of Sterling, as well as the smaller filter-beds which receive the drainage from a few houses near Sterling Junction, the Worcester County Training School at West Boylston and from the swimming pool at Southborough, have been in successful operation and required only the usual attention during the year.

Studies for the disposal of manufacturing wastes, as well as for the disposal of house drainage from the various towns within the drainage area of the Metropolitan Water System, have been in progress during the year.

Constant inspection of the watersheds has been maintained by the Sanitary Inspector and his assistants and members of the maintenance force.

Chemical examinations of the waters used were made by the State Department of Health, and in addition, microscopical and bacterial examinations were made by the Board. These examinations enable the Board to take measures to remedy any difficulties which are found to exist.

The quality of the water brought to the Metropolitan District continues to be satisfactory both in taste and in appearance. This condition results in a large measure from the fact that it is still possible to reject some of the sources which were in use before the extension of the water works to the South Branch of the Nashua River at Clinton. The water derived from the Wachusett watershed has been of superior quality to that coming from the Sudbury and Cochituate sources. The first-named supply, so far as possible, has been that conveyed to the District; the others have been wasted to a greater or less extent as occasion has permitted.

The time, however, is approaching when all the sources will be required for the supply of the District. When that day arrives it will be necessary, without doubt, to filter these inferior waters in order to bring them to the standard of excellence to which the District has become accustomed since the establishment of the Metropolitan water supply.

The subject of adequate filtration has been carefully considered, and whenever the need of such treatment becomes urgent, the Board will be in a position at once to construct the necessary works.

During the year the Board acquired the fee of 103.118 acres of land for the protection and improvement of the water supply.

(5) CLINTON SEWERAGE WORKS.

Certain changes have been made in the treatment of the filter-beds at South Lancaster during the year which have caused the removal of some complaints made of disagreeable odors noticed in the vicinity of the beds at nightfall or during some of the warmer days of the year, and no complaint has reached the Board during the past season which could justly be attributed to the condition of the filter-beds.

(6) FORESTRY.

About 140 acres of the Wachusett Reservoir marginal lands were planted with 171,900 three and four-year-old pine seedlings from the Oakdale nursery. About one-half of these were raised from seed; the remainder were received from the State nursery at Amherst when one year old.

For the purpose of establishing shade trees along the property of the Commonwealth on the highways bordering the reservoir, 1,022 sugar maple saplings were set out along 6½ miles of highway to replace trees that were set out in former years and failed to grow.

Undesirable trees and other growth of an inferior character were cut from 180 acres of land where there was a growth of young white pines from five to eight years old. It has been the policy of the Board to remove, so far as a convenient use of the working force of the department is possible, undesirable trees and underbrush on various portions of the lands controlled by it. In the two nurseries maintained at Oakdale and the North Dike there are at present in good condition 175,650 seedlings.

About 66 acres of Sudbury and Cochituate marginal lands were cleared of trees and brush for planting and on these lands and along the aqueducts 124,175 three and four-year-old seedlings were set out. There are now in the Sudbury nursery 106,000 seedlings which will be ready for transplanting next spring.

The ravages of the gypsy and brown-tail moths and of the elm-leaf beetle have continued during the year, requiring a large amount of work and considerable expense to protect the trees on lands controlled by the Board. The egg clusters of the gypsy moth have been painted with creosote and nests of the brown-tail moths destroyed by burning, and extensive spraying has been required for the preservation of trees infested by moths and elm-leaf beetles.

(7) WACHUSSETT POWER PLANT.

The hydro-electric power station at the Wachusett Dam was operated on 241 days during the year. The daily output varied from the minimum amount which the Connecticut River Transmission Company is required to take under its contract, to the full capacity of the plant. The operation of the plant continues to be successful, the gross earnings for the year being \$26,252.29. The cost of operating the plant has been \$8,125.47, the net earnings \$18,126.82, and the net earnings per thousand kilowatt hours generated, \$3.661.

(8) RAINFALL AND WATER SUPPLY.

The rainfall is still below the average, but somewhat more than in the preceding year. On the Wachusett watershed the rainfall was 44.65 inches and on the Sudbury watershed 43.93 inches, while the averages for the periods covered by the records have been, respectively, 45.39 inches and 44.79 inches.

The Wachusett watershed yielded a daily average of 942,000 gallons of water per square mile, and the Sudbury watershed yielded a

daily average of 719,000 gallons. The Wachusett watershed yielded a daily average of 1,066,000 gallons per square mile, for the 19 years during which measurements have been made, and the daily average per square mile from the Sudbury watershed during the 41 years for which records have been kept has been 988,000 gallons.

(9) WATER CONSUMPTION.

During the year the quantity of water supplied to the Metropolitan Water District amounted to a daily average of 101,941,500 gallons, as measured by Metropolitan Water Works meters, which was equivalent to 88 gallons for each person in the District. This quantity was 5,094,600 gallons less than the average daily consumption of the preceding year.

Acting under the authority conferred by several statutes and arrangements which have been made, water has been supplied to a limited extent outside of the Metropolitan Water District. There has been drawn from the open channel of the Wachusett Aqueduct for the use of the Westborough State Hospital a daily average quantity of 188,000 gallons. The town of Framingham has, under the provision of the statute, drawn indirectly from Farm Pond a daily average quantity of 626,301 gallons and directly from the Sudbury Aqueduct 157,260 gallons. A portion of the town of Saugus has been supplied through the town of Revere with an average of 14,700 gallons daily. The United States Government, for use on Peddock's Island, has been supplied with a daily average of 77,100 gallons, and a daily average of 128,219 gallons has been furnished to the city of Worcester as an emergency supply. The sums charged for the water thus supplied have amounted to \$7,301.73.

V. WATER WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, disbursements, assets and liabilities of the Board for the State fiscal year, beginning with December 1, 1914, and ending with November 30, 1915, was, in accordance with the requirements of chapter 235 of the Acts of the year 1906, presented to the General Court in January last, and a copy of this financial abstract is printed as Appendix No. 6.

As required by said chapter a detailed statement of its doings for the calendar year 1915, in relation to the Metropolitan Water Works, is herewith presented.

CONSTRUCTION.

(1) WATER LOANS — RECEIPTS AND PAYMENTS.

Total loans authorized to January 1, 1916,	\$42,798,000 00
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Receipts from the sales of property applicable to the construction and acquisition of works: —

For the period prior to January 1, 1915,	\$242,927 00
For the year ending December 31, 1915,	2,006 56
	<hr/>
	244,933 56

Receipt from town of Swampscott for admission to District (St. 1909, c. 320),	90,000 00
	<hr/>

Total amount authorized to January 1, 1916,	\$43,132,933 56
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Amounts approved by Board for payments out of Water Loan Fund: —

Payments prior to January 1, 1915,	\$42,414,140 55
Approved for year ending December 31, 1915,	404,030 09
	<hr/>
	42,818,170 64

Amount authorized but not expended January 1, 1916,	\$314,762 92
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(2) TOTAL WATER DEBT, DECEMBER 31, 1915.

Water Loan Outstanding, Sinking Fund and Debt.

Bonds issued by the Treasurer of the Commonwealth: —

Sinking fund bonds (3 and 3½ per cent.),	\$41,398,000 00
Serial bonds (3½ and 4 per cent.),	1,138,000 00
	<hr/>
Total bond issue to December 31, 1915,	\$42,536,000 00

Serial bonds paid prior to January 1, 1915,	\$25,000 00
Serial bonds paid in 1915,	17,000 00
	<hr/>
	42,000 00

Total bond issue outstanding December 31, 1915,	\$42,494,000 00
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Gross Water Debt,	\$42,494,000 00
Sinking fund December 31, 1915,	12,491,245 25
	<hr/>

Net Water Debt December 31, 1915,	\$30,002,754 75
A decrease for the year of \$484,791.80.	

(3) METROPOLITAN WATER LOAN AND SINKING FUND,
DECEMBER 31, 1915.

YEAR.	Authorised Loans.	Bonds issued (Sinking Fund).	Bonds issued (Serial Bonds).	Sinking Fund.
1895,	\$27,000,000	\$5,000,000	-	\$226,286 05
1896,	-	2,000,000	-	699,880 70
1897,	-	6,000,000	-	954,469 00
1898,	-	4,000,000	-	1,416,374 29
1899,	-	3,000,000	-	1,349,332 97
1900,	-	1,000,000	-	1,578,619 72
1901,	13,000,000	10,000,000	-	1,662,436 95
1902,	-	3,500,000	-	2,256,803 81
1903,	-	1,500,000	-	2,877,835 59
1904,	-	2,500,000	-	3,519,602 92
1905,	-	650,000	-	4,207,045 69
1906,	500,000	1,350,000	-	4,897,822 62
1907,	-	-	-	5,643,575 69
1908,	398,000	-	-	6,419,283 28
1909,	900,000	398,000	-	7,226,262 31
1910,	80,000	500,000	-	8,089,902 91
1911,	212,000	-	\$200,000	8,953,437 44
1912,	600,000	-	190,000	9,829,356 80
1913,	108,000	-	-	10,767,701 68
1914,	-	-	258,000	11,533,453 45
1915,	-	-	490,000	12,491,245 25
	\$42,798,000	\$41,398,000	\$1,138,000	

(4) WATER ASSESSMENT, 1915.

The following water assessment was made by the Treasurer of the Commonwealth upon the various municipalities:—

Sinking fund requirements,	\$276,733 97
Serial bonds,	\$30,000 00
Less premium,	7,933 10
	22,066 90
Interest,	1,447,905 41
Maintenance:—	
Appropriated by Legislature,	\$460,835 00
Less balance on hand,	43,211 74
	417,623 26
Total water assessment for 1915,	\$2,164,329 54

In accordance with chapter 488, Acts of 1895, as amended in 1901, 1904 and 1906, the proportion to be paid by each city and town is based one-third in proportion to their respective valuations and the remaining two-thirds in proportion to their respective water consumption for the preceding year, except that but one-fifth of the total valuation and no consumption has been taken for the city of Newton, as it has not been supplied with water from the Metropolitan Works.

The division of the assessment for 1915 was as follows:—

CITIES AND TOWNS.	Assessment.	CITIES AND TOWNS.	Assessment.
Arlington,	\$17,850 63	Nahant,	\$5,574 45
Belmont,	10,106 51	Newton,	6,124 92
Boston,	1,665,006 20	Quincy,	50,070 54
Chelsea,	49,742 74	Revere,	28,816 53
Everett,	47,776 83	Somerville,	110,781 34
Lexington,	8,437 21	Stoneham,	7,269 00
Malden,	45,702 09	Swampscott,	11,858 74
Medford,	27,821 61	Watertown,	19,942 86
Melrose,	19,321 32	Winthrop,	15,695 24
Milton,	16,430 78		\$2,164,329 54

(5) SUPPLYING WATER TO CITIES AND TOWNS OUTSIDE OF DISTRICT AND TO WATER COMPANIES.

Sums have been received during the year 1915 under the provisions of the Metropolitan Water Act, for water furnished, as follows:—

Town of Framingham,	\$1,478 61
Town of Revere (on account of water furnished to a portion of the town of Saugus for 1914),	250 00
United States Government (for Peddock's Island),	1,955 60
Westborough State Hospital,	1,698 69
Wakefield,	7,800 31
Worcester,	1,357 20
	\$14,540 41

The sums so received prior to March 23, 1907, were annually distributed among the cities and towns of the District; but since that

date, in accordance with the provisions of chapter 238 of the Acts of 1907, the sums so received have been paid into the sinking fund.

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works:—

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1915.
Administration applicable to all parts of the construction and acquisition of the works,	\$821 60
Wachusett Department,	456 44
Power Plant at Sudbury Dam,	50,151 16
 Distribution system:—	
Low service:—	
Lowering pipe at Chelsea Creek,	\$25,257 67
Southern high service:—	
Section 43 (24-inch main in Dorchester through Milton to Quincy),	29,131 45
Southern extra high service:—	
Section 42 (20-inch main to reservoir on Bellevue Hill),	1,460 46
Bellevue Reservoir on Bellevue Hill in Boston,	47,000 60
Weston Aqueduct supply mains,	223,570 52
	326,420 70
 Stock — pipes, valves, castings, etc., purchased and sent first to storage yards, and later transferred, as needed, to the various parts of the work:—	
Amount received,	\$159,107 53
Transferred from storage yards to the various sections of the work and included in costs of special works,	137,143 96
	21,963 57
 Acquisition of existing water works:—	
Completed works, City of Boston,	4,216 62
	\$404,030 09
Amount charged from beginning of work to January 1, 1915,	42,414,140 55
	\$42,818,170 64

Maintenance and Operation.	For the Year ending December 31, 1915.
Administration,	\$18,114 12
General supervision,	28,256 33
Taxes and other expenses,	41,229 48
Wachusett Department: —	
Superintendence,	38,086 17
Reservoir,	5,985 09
Forestry,	14,298 86
Protection of supply,	26,990 59
Buildings and grounds,	4,817 28
Wachusett Dam,	4,069 84
Wachusett Aqueduct,	8,920 56
Clinton sewerage system: —	
Pumping station,	1,427 31
Sewers, screens and filter-beds,	5,256 07
Sanitary inspection,	2,729 02
Swamp drainage,	1,809 26
Power plant,	5,235 47
	86,455 52
Sudbury Department: —	
Superintendence, Framingham office,	\$10,123 64
Ashland Reservoir,	1,860 90
Hopkinton Reservoir,	2,238 37
Whitehall Reservoir,	899 34
Framingham Reservoirs Nos. 1, 2 and 3,	6,041 87
Sudbury Reservoir,	9,702 80
Lake Cochituate,	3,977 96
Marlborough Brook filters,	2,194 00
Pegan filters,	3,690 51
Sudbury and Cochituate watersheds,	1,163 61
Sanitary inspection,	3,143 52
Cochituate Aqueduct,	3,031 17
Sudbury Aqueduct,	6,387 12
Weston Aqueduct,	5,071 09
Forestry,	8,266 90
Improvement and protection of water supplies,	12,580 74
Payments under Industrial Accident Law and special benefit appropriations,	784 84
	80,157 47
Distribution Department: —	
Superintendence,	\$4,554 44
Arlington pumping station, pumping service,	8,379 81
Chestnut Hill low-service pumping station, pumping service,	50,000 55
Chestnut Hill high-service pumping station, pumping service,	16,002 43
Spot Pond pumping station, pumping service,	14,608 00
Hyde Park pumping station, pumping service,	6,858 14
Bear Hill Reservoir,	292 15
Chestnut Hill Reservoir and grounds,	11,390 57
Falls Reservoir,	512 50
Forbes Hill Reservoir,	1,359 25
Mystic Lake, conduit and pumping station,	2,148 30
Mystic Reservoir,	1,658 29
Amounts carried forward,	\$117,664 43 \$257,212 92

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1915.
<i>Amounts brought forward,</i>	\$117,664 43 \$257,212 92
Distribution Department — <i>Con.</i>	
Waban Hill Reservoir,	238 70
Weston Reservoir,	4,244 78
Spot Pond,	12,099 81
Buildings at Spot Pond,	271 27
Pipe lines: —	
Low service,	19,476 83
Northern high service,	4,907 09
Northern extra high service,	78 20
Southern high service,	5,175 21
Southern extra high service,	610 57
Supply pipe lines,	5,395 17
Buildings at Chestnut Hill Reservoir,	849 73
Chestnut Hill pipe yard,	1,455 03
Glenwood pipe yard and buildings,	3,112 68
Stables,	6,383 15
Venturi meters,	921 74
Measurement of water,	1,663 88
Arlington pumping station, buildings and grounds,	476 30
Hyde Park pumping station, buildings and grounds,	168 70
Fisher Hill Reservoir,	2,292 53
Payments under Industrial Accident Law and special benefit appropriations,	370 00
Improvement and protection of water supplies,	2,593 90
	190,446 70
Total for maintaining and operating works,	\$447,659 62

*

(7) DETAILED FINANCIAL STATEMENT UNDER METROPOLITAN
WATER ACT.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1915.

(a) *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1915, and ending December 31, 1915, was \$404,030.09, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1915, has been \$42,818,170.64.

For maintenance and operation the expenditures for the year were \$447,659.62.

The salaries of the commissioners, and the other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character:—

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1915.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.	
<i>Administration.</i>	
Commissioners,	\$100 00
Clerks and stenographers,	160 00
Stationery and printing,	349 39
Postage, express and telegrams,	43
Telephone, lighting, heating, water and care of building,	85 32
Alterations and repairs of building,	44
Rent and taxes, main office,	113 62
Miscellaneous expenses,	12 40
	<hr/>
	821 60
<i>Engineering.</i>	
Chief engineer,	\$305 13
Principal assistant engineers,	2,558 87
Engineering assistants,	9,299 74
Consulting engineers,	1,050 00
Inspectors,	6,511 02
Railroad and street car travel,	773 83
Wagon hire,	1 00
Stationery and printing,	294 33
Postage, express and telegrams,	3 71
Engineering and drafting supplies,	33 63
Engineering and drafting instruments and tools,	127 35
Books, maps and photographic supplies,	48 66
Telephone, lighting, heating, water and care of buildings:—	
Main office,	256 03
Sub-offices,	13 71
Alterations and repairs of building — main office,	1 31
Rent and taxes, main office,	340 87
Miscellaneous expenses,	381 15
	<hr/>
	21,998 84
<i>Construction.</i>	
Preliminary work:—	
Advertising,	\$107 39
Labor,	65 00
Tools, machinery, appliances and hardware supplies,	2 50
	<hr/>
	174 89
Amount carried forward,	<hr/>
	\$22,995 33

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1915.
<i>Amount brought forward,</i>	\$22,995 33
<i>Construction — Con.</i>	
Contracts, Distribution System: —	
Coleman Bros., lowering pipe at Chelsea Creek, Contract 354,	\$16,647 11
John J. Evans, for laying water pipe in Boston, Milton and Quincy, Section 43 of southern high service, Contract 359,	9,990 93
Charles R. Gow Co., for laying water pipe in Boston, Section 42 of southern extra high service, Contract 360,	1,034 74
John E. Palmer, for constructing foundation for reservoir on Bellevue Hill in Boston, Contract 361,	957 34
Pratt & Cady Co., for furnishing water valves, Contract 367,	3,225 00
Standard Cast Iron Pipe & Foundry Co., for furnishing special castings, Contract 368,	4,634 07
Walsh's Holyoke Steam Boiler Works, for building steel tank or reservoir on Bellevue Hill in Boston, Contract 357,	5,895 14
Walsh's Holyoke Steam Boiler Works, for furnishing and laying steel pipes on Section 5 of the Weston Aqueduct Supply Mains, Contract 366 (in part),	1,720 00
Walsh's Holyoke Steam Boiler Works, for furnishing and laying steel pipes on Section 43 of the southern high service pipe lines, Contract 366 (in part),	1,600 00
United States Cast Iron Pipe and Foundry Co., for cast-iron water pipe and special castings, Contract 362,	78,838 14
United States Cast Iron Pipe and Foundry Co., for cast-iron water pipe and special castings, Contract 363,	70,640 96
John Cashman & Sons Co., for building masonry tower on Bellevue Hill in Boston, Contract 368,	34,106 51
Andrew M. Cusack, for laying water pipes in portion of Section 5 of the Weston Aqueduct Supply Mains in Newton, Contract 369,	40,597 13
Charles A. Kelley, for laying water pipes in portion of Section 5 of the Weston Aqueduct Supply Mains in Newton, Contract 370,	27,633 62
Contracts, Power Plant at Sudbury Dam: —	
United States Cast Iron Pipe and Foundry Co., for furnishing special castings, Contract 371,	1,082 55
Wonham, Sanger & Bates, Inc., for building and erecting hand power traveling crane and runway at the Power House at Sudbury Dam, Contract 372,	880 00
Westinghouse Electric & Mfg. Co., for furnishing and installing hydroelectric machinery at Sudbury Dam, Contract 364A,	5,000 00
	304,386 24
<i>Additional work: —</i>	
Labor,	\$30,740 38
Professional services, physicians, chemists, et als.,	146 27
Traveling,	27 50
Rent,	129 14
Freight and express,	907 70
Jobbing and repairing,	35 75
<i>Amounts carried forward,</i>	\$40,986 74 \$327,381 57

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1915.
<i>Amounts brought forward,</i>	\$40,986 74 \$327,381 57
<i>Construction — Con.</i>	
Additional work — <i>Con.</i>	
Tools, machinery, appliances, and hardware supplies,	3,796 01
Electrical supplies,	474 45
Castings, ironwork and metals,	1,500 94
Iron pipe and valves,	1,576 36
Blasting supplies,	15 50
Paint and coating,	686 17
Fuel, oil and waste,	1,006 03
Lumber and field buildings,	2,314 71
Brick, cement and stone,	1,084 28
Sand, gravel and filling,	75 00
Municipal and corporation work,	17,012 91
Unclassified supplies,	166 21
Miscellaneous expenses,	680 15
	71,975 46
<i>Real Estate.</i>	
Legal and expert: —	
Conveyancing expenses,	1 44
<i>Damages.</i>	
Legal and expert: —	
Legal services,	85 00
Settlements,	450 00
	455 00
<i>Purchase of Existing Water Works.</i>	
Settlements: —	
City of Boston, completed works,	4,216 62
	\$404,030 09
Amount charged from beginning of work to January 1, 1915,	42,414,140 55
Total amount of construction expenditures to January 1, 1916,	\$42,818,170 64

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1915.
MAINTENANCE AND OPERATION OF WORKS.	
Administration:—	
Commissioners,	\$7,191 67
Secretary and assistants,	7,780 94
Rent,	542 85
Repairs of building,	8 14
Fuel,	89 29
Lighting,	74 90
Care of building,	518 14
Postage,	181 52
Printing, stationery and office supplies,	1,457 22
Telephones,	114 83
Traveling expenses,	105 61
Miscellaneous expenses,	115 11
	<hr/>
	\$18,114 12
General supervision:—	
Chief engineer and assistants,	\$21,748 00
Rent,	1,628 63
Repairs of building,	108 56
Fuel,	117 91
Lighting,	224 70
Care of building,	1,539 58
Postage,	121 15
Printing, stationery and office supplies,	555 55
Telephones,	412 12
Traveling expenses,	841 03
Miscellaneous expenses,	959 10
	<hr/>
	28,256 33
Pumping service:—	
Labor,	\$62,916 27
Fuel,	29,468 66
Oil, waste and packing,	1,023 26
Repairs,	1,533 52
Small supplies,	807 22
	<hr/>
	95,748 93
Reservoirs, aqueducts, pipe lines, buildings and grounds:—	
Superintendents,	\$7,320 00
Engineering assistants,	8,641 22
Sanitary inspectors,	4,056 18
Labor, pay roll,	162,016 19
Labor, miscellaneous,	2,746 08
Alterations and repairs of pumping stations,	260 23
Alterations and repairs of other buildings and structures,	545 09
Automobiles,	5,805 14
Brick,	157 66
Brooms, brushes and janitor's supplies,	228 61
Castings, ironwork and metals,	1,311 29
Cement and lime,	352 71
Drafting and photo supplies,	167 50
	<hr/>
Amounts carried forward,	\$193,607 90 \$142,119 38

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1915.
<i>Amounts brought forward,</i>	\$198,607 90 \$142,119 38
Reservoirs, aqueducts, pipe lines, buildings and grounds — <i>Con.</i>	
Fertiliser and planting material,	1,758 44
Freight and express,	256 59
Fuel,	1,702 15
Gypsy moth supplies,	1,154 26
Hardware,	1,431 47
Hay and grain,	1,729 02
Lighting,	239 46
Lumber,	2,726 92
Machinery,	976 66
Paints and oils,	1,294 54
Pipe and fittings,	891 78
Postage,	61 65
Printing, stationery and office supplies,	441 60
Rubber and oiled goods,	426 65
Stable expenses,	592 07
Sand, gravel and stone,	377 99
Traveling expenses,	2,886 40
Telephones,	970 00
Teaming,	787 43
Tools and appliances,	2,788 29
Vehicles, harnesses and fittings,	221 99
Miscellaneous expenses,	43,121 92
Contracts:—	
Thomas Russo & Co., Contract 44-M, for constructing surface drains at Spot Pond,	3,130 74
Payments under Industrial Accident Law and special benefit appropriations,	1,154 84
Payments in lieu of taxes,	264,810 76 41,229 48
Total expenditures for maintenance and operation,	\$447,659 62

(b) *Receipts.*

The total amount of receipts from the operations of the Board and from sales of property for the year beginning January 1, 1915 and ending December 31, 1915, was \$241,924.50, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1915, has been \$1,252,545.80. The general character of these receipts is as follows:—

GENERAL CHARACTER OF RECEIPTS.	For the Year ending December 31, 1915.
Applicable to the loan fund: —	
Land and buildings,	\$222 40
Construction tools, supplies and reimbursements,	1,784 16
	<u>3,006 56</u>
Applicable to payment of expenses of maintenance and operation: —	
Proceeds from operations of the Board: —	
Rents,	\$1,542 50
Land products,	6,556 41
Electric energy,	25,718 86
Maintenance labor, tools, supplies and reimbursements,	6,342 65
Interest and unclassified receipts,	314 34
	<u>40,469 76</u>
Applicable to the sinking fund: —	
Water supplied to cities and towns, water companies and others,	\$14,540 41
Reimbursement and payment for damages under Chap. 456, Acts 1897 and Chap. 351, Acts 1902,	184,907 77
	<u>199,448 18</u>
	\$241,924 50
Amount credited from beginning of work to January 1, 1915,	1,010,621 30
Total receipts to January 1, 1916,	<u>\$1,252,545 80</u>

The foregoing receipts have been credited to the various objects or works, as follows: —

SOURCES OF RECEIPTS.	For the Year ending December 31, 1915.
Supplying water outside of Water District,	\$14,540 41
Construction and acquisition of works: —	
Administration,	\$81 25
Wachusett Reservoir,	184,907 77
Sudbury Reservoir,	27 72
Distribution system,	1,921 34
	<u>186,938 08</u>
Maintenance and operation of works: —	
Administration,	\$191 58
General supervision,	200 89
Wachusett Aqueduct,	90 95
Wachusett Reservoir,	5,870 58
Electric power plant,	25,726 86
Sudbury system,	2,145 67
Distribution system,	3,468 17
Clinton sewerage system,	2,751 31
	<u>40,446 01</u>
	\$241,924 50
Amount credited from beginning of work to January 1, 1915,	<u>1,010,621 30</u>
Total receipts to January 1, 1916,	<u>\$1,252,545 80</u>

(c) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board:—

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; completed works, real estate and buildings connected therewith.

(d) *Liabilities.*

The sums due on monthly pay rolls amount to \$562.61 and there are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
Camoia & Williams, . . .	Contract 308, Section 33 of northern high-service pipe lines, Distribution System.	\$200 00
Joseph Hanreddy, . . .	Contract 314, Section 7 of Weston Aqueduct Supply Mains.	10 00
John Cashman & Sons Co., . . .	Contract 368, for building masonry tower on Bellevue Hill in Boston.	6,019 33
Andrew M. Cusack, . . .	Contract 369, for portion of Section 5 of Weston Aqueduct Supply Mains.	4,581 85
Charles A. Kelley, . . .	Contract 370, for portion of Section 5 of Weston Aqueduct Supply Mains.	4,417 70
Thomas Russo & Co., . . .	Contract 44-M, for constructing surface drains at Spot Pond.	552 48

Claims have been made by the following parties for land taken:— John Ward *et al.*, heirs of George K. Ward, Town of Framingham, William H. Buck, heirs of Harrison Eames, Lizzie W. Sampson.

VI. METROPOLITAN SEWERAGE WORKS.

The North Metropolitan Sewerage District embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Revere, Somerville and Woburn, and the towns of Arlington, Belmont, Stoneham, Wakefield, Winchester and Winthrop and parts of the city of Boston and the town of Lexington,—comprising in all 10 cities and 7 towns, with an area of 90.50 square miles. The district has an estimated population, based upon the census of 1915, as of December 31, 1915, of 601,810. Of the total population it is estimated that

90.1 per cent., or 542,575 people, contribute sewage to the North Metropolitan System.

The South Metropolitan Sewerage District includes the cities of Newton, Quincy and Waltham, and the towns of Brookline, Milton, Watertown and Wellesley, and parts of the city of Boston and the town of Dedham, — a total of 4 cities and 5 towns. This district has an area of 110.76 square miles, with an estimated population as of December 31, 1915, of 438,580. According to the estimates made 68.5 per cent. of this population, or 300,435, contribute sewage to the South Metropolitan System.

(1) NORTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

The amount expended for construction on account of the North Metropolitan System during the past year was \$34,308.85.

A beginning has been made in the construction of the extension of the Deer Island outfall, authorized by chapter 344 of the Acts of 1914.

The progress of this work will be controlled largely by the weather conditions at this exposed headland, but with a favorable season it is probable that the new outlet will be ready for service before the end of the year, and a substantial even if not complete relief will be obtained from the increasingly offensive discharge of sewage at this point. The success which has been obtained at the deep water outlets for sewage near Peddock's Island gives assurance of equally good results here.

The Board was directed by chapter 215 of the Acts of 1915 to lower the Metropolitan sewerage siphon under Malden River so as to dredge a river channel of greater depth than is possible with the sewer at its present level.

After consultation with the Port Directors it was decided to lower the siphon to a level which would make possible a channel 20 feet deep. Work is under way and will be completed this season.

(2) NORTH METROPOLITAN SEWERAGE SYSTEM — MAINTENANCE.

The cost of the maintenance and operation of the North Metropolitan System during the past year was \$174,123.78.

Sewers and Pumping Stations.

The Metropolitan sewers in the North Metropolitan System now extend a distance of 63.691 miles, and the local sewers which are

connected with the Metropolitan sewers have a further length of 743.35 miles, involving 80,748 connections.

The sewage of the North Metropolitan District flows at first by gravity, but before being finally disposed of is lifted at different points by pumping and is finally discharged into the harbor from an outfall off Deer Island.

The daily average amount of sewage discharged into the harbor was 60,392,000 gallons, a daily average for each person contributing sewage of 111 gallons. The increase in the total amount of sewage discharged was 1,692,000 gallons per day more than the discharge of the preceding year. The maximum rate of discharge in any one day was 151,600,000 gallons.

The pumping stations operated for the North Metropolitan Sewerage System are as follows:—

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Deer Island station (Boston harbor),	4	235,000,000	19
East Boston station,	4	235,000,000	19
Charlestown station,	3	104,000,000	{ 11 8
Alewife Brook station (Somerville),	3	22,000,000	13

There were purchased for the operation of the pumping stations 7,067 tons of bituminous coal, the average prices of which, at the different stations, varied from \$4.00 to \$5.08 per gross ton delivered in the bins.

The amount expended for the stations was \$101,604.06. The average cost per million gallons of sewage lifted per foot at the several stations, was \$0.135, a decrease of about 7.5 per cent. from the cost last year.

(3) SOUTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

The amount expended for construction on account of the South Metropolitan System during the past year was \$87,961.86.

The relief outfall at Nut Island is finished and has been put in service. This addition provides a sufficient outfall for all the sewage and storm waters which can reach this station for many years.

The town of Wellesley was admitted to the South Metropolitan Sewerage District by chapter 343 of the Acts of 1914, and the act was accepted by the town in March, 1915.

The necessary surveys were at once undertaken and as soon as possible contracts were awarded for four sections out of the nine into which the sewer was divided. At the end of the year two of these sections are practically completed. Great difficulties were met in the construction of the upper section from the presence in the lower levels of the trench of a sand finer than any hitherto found in any of the works carried on under the direction of this Board.

The five remaining sections of this sewer will be placed under contract at a date early enough to permit the completion of the whole line down to the connection with the main sewer in West Roxbury in the season of 1917.

The Board acquired by taking, during the year, easements in 3.011 acres of land in Needham and Wellesley for the construction of the Wellesley Extension of the High-level sewer.

(4) SOUTH METROPOLITAN SEWERAGE SYSTEM — MAINTENANCE.

The entire cost of maintenance of the South Metropolitan System during the past year was \$108,865.70.

Sewers and Pumping Stations.

The Metropolitan sewers in the South Metropolitan System, which comprise the old Charles River valley sewer and Neponset River valley sewer, as well as the new High-level sewer and extensions, have a total length of 45.139 miles, and with these are connected local sewers having a length of 627.61 miles, involving 42,091 connections.

The pumping stations operated for the South Metropolitan Sewerage System are as follows:—

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Ward Street station (Roxbury District),	2	100,000,000	45
Quincy station,	3	18,000,000	28
Quincy sewerage lifting station,	2	3,000,000	20

The sewage of two small districts in Dorchester and Milton, included in the Neponset River valley system, which are too low for sewage to be delivered into the High-level sewer by gravity, is, under an arrangement with the city of Boston, disposed of through the Boston Main Drainage Works at Moon Island. By this arrangement the Board is relieved from the expense of providing extra pumping facilities.

A large part of the sewage of the District is lifted into the High-level sewer at the Ward Street pumping station in Roxbury. Most of the sewage of the city of Quincy is pumped into the High-level sewer at Greenleaf Street near the Quincy pumping station. The entire sewage is screened at the Nut Island screen-house for the purpose of intercepting solid matter, and is thence discharged at the bottom of the harbor from the outfalls about a mile off the island.

The daily average amount of sewage thus discharged was 52,300,-000 gallons, and the largest rate of discharge in a single day was during a heavy storm, when the amount reached 155,000,000 gallons. The decrease in the daily average from last year was 300,000 gallons. The daily average discharge of sewage for each individual contributing sewage in the district was 174 gallons.

There were 3,237 gross tons of bituminous coal purchased at the two pumping stations and screen-house, the average prices of which varied from \$4.37 to \$4.89 per gross ton delivered in the bins.

The total amount expended for the operation of the stations was \$63,103.18.

VII. SEWERAGE WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the fiscal year of the Commonwealth ending with November 30, 1915, was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906, and a copy of this financial abstract is in part printed as Appendix No. 6.

The following statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1915, is herewith presented, in accordance with the provisions of the act of 1906, as a part of the annual report of the Board.

(1) METROPOLITAN SEWERAGE LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, the expenditures for construction, and the balances available on January 1, 1916, have been as follows:—

North Metropolitan System.

Loans authorized under various acts prior to 1915 for the construction of the North Metropolitan System and the various extensions, \$7,144,365 73

Loans authorized under Acts of 1915:—

Chapter 215 (Malden River Siphon, Section 19), 70,000 00

Balance from Chapter 775, Acts of 1914 (applied to North Metropolitan Loan Fund under Resolve 76, Acts of 1915), 13,000 00

Receipts from sales of real estate and from miscellaneous sources which are placed to the credit of the North Metropolitan System:—

For the year ending December 31, 1915, \$153 27

For the period prior to January 1, 1915, 85,363 52

85,516 79

\$7,312,882 52

Amount approved for payment by the Board¹ out of the Metropolitan Sewerage Loan Fund, North System:—

For the year ending December 31, 1915, \$34,308 85

For the period prior to January 1, 1915, 7,091,329 10

7,125,637 95

Balance, North Metropolitan System, January 1, 1916, \$187,244 57

South Metropolitan System.

Loans authorized under the various acts, prior to 1915, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extensions, constituting the South Metropolitan System, \$8,867,046 27

Loans authorized under Acts of 1915:—

Chapter 343 (Wellesley extension), 350,000 00

Chapter 210 (additional for completion of Relief Outfall, Section 43), 5,000 00

Amount carried forward, \$9,222,046 27

¹ The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

Amount brought forward, \$9,222,046 27

Receipts from pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System:—

For the year ending December 31, 1915,	\$4,978 13
For the period prior to January 1, 1915,	14,092 01
	<hr/>
	19,070 14
	<hr/>
	\$9,241,116 41

Amount approved by the Board for payment out of the Metropolitan Sewerage Loan Fund, South System:—

On account of the Charles River valley sewer,	\$800,046 27
On account of the Neponset valley sewer,	911,531 46
On account of the High-level sewer and extensions, including Wellesley extension:—	
For the year ending December 31, 1915,	\$87,961 86
For the period prior to January 1, 1915,	7,144,058 55
	<hr/>
	7,232,020 41
	<hr/>
	8,943,598 14

Balance, South Metropolitan System, January 1, 1916, \$297,518 27

(2) TOTAL SEWERAGE DEBT, DECEMBER 31, 1915.

North Metropolitan System.

Bonds issued by the Treasurer of the Commonwealth:—

Sinking fund bonds (3½ and 3 per cent.),	\$6,563,000 00
Serial bonds (3½ and 4 per cent.),	570,500 00
	<hr/>
Total bond issue to December 31, 1915,	\$7,133,500 00
Serial bonds paid prior to January 1, 1915,	\$16,000 00
Serial bonds paid in 1915,	13,000 00
	<hr/>
Total bond issue outstanding December 31, 1915,	\$7,104,500 00

Gross Sewerage Debt,	\$7,104,500 00
Sinking fund December 31, 1915,	2,095,509 86
	<hr/>

Net Sewerage Debt December 31, 1915,	\$5,008,990 14
A decrease for the year of \$55,517.56.	

South Metropolitan System.

Bonds issued by the Treasurer of the Commonwealth: —

Sinking fund bonds (3 and 3½ per cent.),	\$8,877,912 00
Serial bonds,	—
Total bond issue to December 31, 1915,	\$8,877,912 00
Gross Sewerage Debt,	\$8,877,912 00
Sinking fund December 31, 1915,	1,195,469 60
Net Sewerage Debt December 31, 1915,	\$7,682,442 40
A decrease for the year of \$106,449.46.	

(3) NORTH AND SOUTH METROPOLITAN LOAN AND SINKING FUNDS,
DECEMBER 31, 1915.

YEAR.	LOANS.		BONDS ISSUED (SINKING FUND).		BONDS ISSUED (SERIAL BONDS).	SINKING FUND.
	North System.	South System.	North System.	South System.		
1889,	\$5,000,000 00	—	—	—	—	—
1890,	—	—	\$2,200,000	\$800,000	—	—
1891,	—	—	368,000	—	—	—
1892,	—	—	1,053,000	—	—	—
1893,	—	—	670,000	—	—	—
1894,	500,000 00	—	500,000	—	—	—
1895,	300,000 00	\$500,000 00	300,000	300,000	—	—
1896,	30,000 00	—	30,000	200,000	—	—
1897,	85,000 00	300,000 00	80,000	300,000	—	—
1898,	215,000 00	35,000 00	220,000	35,000	—	—
1899,	—	4,625,000 00	—	1,025,000	—	\$361,416 59
1900,	265,000 00	10,912 00 ¹	265,000	10,912	—	454,520 57
1901,	—	40,000 00	—	2,040,000	—	545,068 28
1902,	—	—	—	384,000	—	636,084 04
1903,	500,000 00	1,000,000 00	500,000	1,736,000	—	754,690 41
1904,	—	392,000 00	—	392,000	—	878,557 12
1905,	—	—	—	—	—	1,008,724 95
1906,	55,000 00	1,175,000 00	55,000	175,000	—	1,146,998 68
1907,	—	—	—	300,000	—	1,306,350 30
1908,	413,000 00	—	—	700,000	—	1,492,418 98
1909,	—	—	—	—	—	1,673,784 40
1910,	56,000 00	—	200,000	—	—	1,931,741 89
1911,	6,000 00	—	113,000	—	—	2,184,674 98
1912,	378,000 00	—	—	—	\$62,000	2,458,541 20
1913,	—	—	—	—	378,000	2,749,337 90
1914,	130,500 00	—	—	—	—	3,011,512 44
1915,	83,000 00	—	—	—	130,500	3,290,379 46
	\$8,016,500 00 ²	\$8,432,912 00	—	—	—	—
	789,134 27	789,134 27	—	—	—	—
	\$7,227,365 73	\$9,222,046 27	\$6,563,000	\$8,877,912	\$570,500	—

¹ The sum of \$10,912 was appropriated to reimburse the town of Watertown for the expense of constructing the Watertown siphon.² Of this amount \$789,134.27 was expended for the construction of the Charles River valley sewer, which is now included in the South Metropolitan System.

(4) ANNUAL APPROPRIATIONS, RECEIPTS AND EXPENDITURES.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1915, were as follows:—

North Metropolitan System.

Appropriations as follows:—

Chapter 157, Acts of 1915,	\$185,500 00
Chapter 775, Acts of 1914 (balance),	10,569 06
Chapter 369, Acts of 1915,	500 00
Receipts from pumping and from other sources,	559 53
	<hr/>
	\$197,128 59
Amount approved by the Board for payment,	174,123 78
	<hr/>
Balance, January 1, 1916,	\$23,004 81

South Metropolitan System.

Appropriations as follows:—

Chapter 156, Acts of 1915,	\$117,855 00
Receipts from pumping and from other sources,	152 33
	<hr/>
	\$118,007 33
Amount approved by the Board for payment,	108,865 70
	<hr/>
Balance, January 1, 1916,	\$9,141 63

(5) SEWER ASSESSMENTS, 1915.

The following sewer assessments were made by the Treasurer of the Commonwealth upon the various municipalities:—

North Metropolitan Sewerage System.

Sinking fund requirements,	\$99,454 95
Serial bonds,	11,976 25
Interest,	222,216 08
Maintenance:—	
Appropriated by Legislature,	\$186,000 00
Less balance on hand,	757 31
	<hr/>
Total North Metropolitan sewerage assessment,	185,242 69
	<hr/>
	\$518,889 97

South Metropolitan Sewerage System.

Sinking fund requirements,	\$64,833 80
Interest,	303,010 70
Maintenance: —	
Appropriated by Legislature,	\$117,855 00
Less balance on hand,	2,772 69
	<hr/>
	115,082 31
Total South Metropolitan sewerage assessment,	\$482,926 81

In accordance with the provisions of chapter 369, Acts of 1906, the proportion to be paid by each city and town to meet the interest and sinking fund requirements for each year is based upon their respective taxable valuations, and to meet the cost of maintenance and operation upon their respective populations.

The divisions of the assessments for 1915 were as follows: —

North Metropolitan Sewerage System.

CITIES AND TOWNS.	Assessment.	CITIES AND TOWNS.	Assessment.
Arlington,	\$14,540 81	Melrose,	\$17,201 57
Belmont,	8,236 13	Revere,	18,557 84
Boston,	84,677 78	Somerville,	70,683 61
Cambridge,	112,675 22	Stoneham,	5,770 53
Chelsea,	28,934 81	Wakefield,	10,578 06
Everett,	30,906 79	Winchester,	13,807 21
Lexington,	4,777 67	Winthrop,	13,803 31
Malden,	42,700 65	Woburn,	12,034 77
Medford,	25,704 21	Total,	<hr/> \$518,589 97

South Metropolitan Sewerage System.

CITIES AND TOWNS.	Assessment.	CITIES AND TOWNS.	Assessment.
Boston,	\$223,686 57	Quincy,	\$30,403 10
Brookline,	92,550 90	Waltham,	26,729 75
Dedham,	11,116 98	Watertown,	15,061 15
Milton,	22,144 92	Total,	<hr/> \$482,926 81
Newton,	61,233 44		

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works:—

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1915.
<i>North Metropolitan System.</i>	
North System, enlargement:—	
Administration,	\$5,281 43
East Boston pumping station, extensions and additions,	42 75
New Mystic sewer,	15,572 22
Section 48A, Somerville and Medford,	1 04
Section 57A, Revere extension,	1,191 56
Deer Island Outfall extension,	10,843 62
Malden River siphon, Section 19,	1,376 23
	<hr/>
	\$34,308 85
Amount charged from beginning of work to January 1, 1915,	7,091,329 10
	<hr/>
Total for North Metropolitan System to January 1, 1916,	\$7,125,637 95
<i>South Metropolitan System.</i>	
High-level sewer,	\$5,792 45
High-level sewer extensions:—	
Administration,	\$757 55
Relief Outfall, Section 43,	24,196 22
Wellesley extension:—	
Section 98,	619 04
Section 99,	199 84
Section 100,	427 32
Section 101,	136 23
Section 102,	363 52
Section 103,	1,960 77
Section 104,	2,460 90
Section 105,	30,896 56
Section 106,	20,092 96
Legal, etc.,	56 50
	<hr/>
	57,213 64
	<hr/>
Amount charged from beginning of work to January 1, 1915,	82,160 41
	<hr/>
	\$87,961 86
Total for South Metropolitan System to January 1, 1916,	8,855,636 28
	<hr/>
Total for construction, both systems,	\$8,943,598 14
	<hr/>
	\$16,069,236 09

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1915.
<i>North Metropolitan System,</i>	
.	\$174,123 78
<i>South Metropolitan System,</i>	
.	108,865 70
	<hr/>
Total for maintenance, both systems,	\$282,989 48

(7) DETAILED FINANCIAL STATEMENT.

The Board herewith presents, in accordance with the Metropolitan Sewerage acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1915: —

(a) *Expenditures and Disbursements.*

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1915.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING. <i>North System Enlargement.</i>	
Administration: —	
Commissioners,	\$2,106 32
Secretary,	750 00
Clerks and stenographers,	1,574 77
Stationery, printing and office supplies,	441 09
Telephone, lighting, heating, water and care of building,	217 88
Rent and taxes, main office,	180 37
	—————
	85,281 43
Engineering: —	
Chief engineer,	8406 25
Engineering assistants,	1,528 37
Inspectors,	263 89
Stationery, printing and office supplies,	172 48
Engineering and drafting instruments and tools,	30 70
Engineering and drafting supplies,	2 77
Telephone, lighting, heating, water and care of building,	653 80
Rent and taxes,	568 13
Miscellaneous expenses,	338 55
	—————
	3,964 94
Advertising,	\$150 81
Labor and teaming,	4,121 84
Tools, machinery and appliances,	412 93
Brick, cement, lumber and other field supplies and expenses,	1,560 80
	—————
	6,255 38
Contracts: —	
G. M. Bryne Co., Contract 112, for constructing Section 57A of the Revere extension in Chelsea and Revere,	\$158 18
Henry Spinach Contracting Co., Contract 110, for constructing part of Section 69 (New Mystic sewer) in Winchester,	5,677 97
Henry Spinach Contracting Co., Contract 111, for constructing part of Section 69 (New Mystic sewer) in Winchester,	9,619 48
George M. Bryne, Contract 131, for constructing Section 1A, Deer Island Outfall extension of the North Metropolitan System at Deer Island in Boston Harbor,	2,354 50
	—————
	17,810 13
Real estate: —	
Legal, conveyancing and expert,	\$121 97
Settlements,	875 00
	—————
	996 97
Total for North Metropolitan System,	\$34,306 85

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1915.
<i>South Metropolitan System.</i>		
<i>High-level Sewer.</i>		
Engineering: —		
Engineers, inspectors, rodmen, laborers and others,	\$184 96	
Postage, telephone and telegrams,	14 10	
Repairs, fittings and supplies, main office,	17 60	
Brick, cement, lumber and other field supplies,	75 70	
		\$292 45
Contracts: —		
Charles A. Haskin, Contract 122, for constructing Siphon Crossing under Section 70 of the High-level sewer in West Roxbury,	\$4,500 00	
E. W. Everson & Son, Contract 14, for constructing Section 75 (in part) of the High-level sewer in Roxbury,	1,000 00	
		5,500 00
<i>High-level Sewer Extensions.</i>		
Administration: —		
Commissioners,	\$308 34	
Clerks and stenographers,	310 80	
Stationery, printing and office supplies,	81 92	
Telephone, lighting, heating, water and care of building,	31 25	
Rent and taxes, main office,	25 24	
		757 55
Engineering: —		
Chief engineer,	\$718 75	
Engineering assistants,	7,498 72	
Inspectors,	1,966 67	
Traveling expenses,	599 51	
Engineering and drafting instruments and tools,	130 53	
Stationery, printing and office supplies,	331 66	
Engineering and drafting supplies,	62 49	
Telephone, lighting, heating, water and care of building,	93 79	
Rent and taxes, main office,	75 75	
Miscellaneous expenses,	869 36	
		12,347 23
Advertising,	\$197 33	
Labor and teaming,	4,286 76	
Tools, machinery and appliances,	1,078 17	
Brick, cement, lumber and other field supplies and expenses,	2,691 76	
		8,254 07
Contracts: —		
W. H. Ellis & Son Co., Contract 120, for constructing part of Section 43, Relief Outfall line of the High-level sewer in Boston Harbor,	\$20,469 10	
Hugh Nawn Contracting Co., Contract 123, for constructing Section 106 of the High-level sewer (Wellesley extension) in Needham and Wellesley,	14,994 21	
Hugh Nawn Contracting Co., Contract 124, for constructing Section 105 of the High-level sewer (Wellesley extension) in Needham,	25,290 75	
		60,754 06
Real estate: —		
Legal, conveyancing and expert,	56 50	
Total for South Metropolitan System,	\$87,961 86	

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1915.
MAINTENANCE AND OPERATION OF WORKS.	
<i>North Metropolitan System.</i>	
Administration:—	
Commissioners,	\$2,250 00
Secretary and assistants,	2,530 49
Rent,	202 00
Heating, lighting and care of building,	218 12
Postage,	20 00
Printing, stationery and office supplies,	546 05
Telephones,	80 98
Traveling expenses,	1 78
Miscellaneous expenses,	38 97
	<u>\$5,838 34</u>
General supervision:—	
Chief engineer and assistants,	\$7,037 25
Rent,	606 00
Heating, lighting and care of building,	654 39
Postage,	10 00
Printing, stationery and office supplies,	257 25
Telephones,	92 80
Traveling expenses,	150 00
Miscellaneous expenses,	12 50
	<u>8,820 19</u>
Deer Island pumping station:—	
Labor,	\$19,860 38
Fuel,	8,396 07
Oil and waste,	640 12
Water,	1,557 60
Packing,	97 65
Repairs and renewals,	1,424 71
Telephones,	18 15
General supplies,	369 65
Miscellaneous supplies and expenses,	537 52
	<u>32,901 85</u>
East Boston pumping station:—	
Labor,	\$20,358 02
Fuel,	10,666 67
Oil and waste,	468 39
Water,	1,656 00
Packing,	55 30
Repairs and renewals,	681 47
Telephones,	8 57
General supplies,	242 39
Miscellaneous supplies and expenses,	520 79
	<u>34,687 60</u>
Charlestown pumping station:—	
Labor,	\$17,001 52
Fuel,	4,359 49
Oil and waste,	210 02
Water,	541 20
<i>Amounts carried forward,</i>	<u>\$22,112 23</u>
	<u>\$32,247 98</u>

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1915.	
<i>Amounts brought forward,</i>	\$22,112 23	\$82,247 98
<i>North Metropolitan System — Con.</i>		
Charlestown pumping station — <i>Con.</i>		
Packing,	69 25	
Repairs and renewals,	626 39	
Telephones,	42 99	
General supplies,	101 45	
Miscellaneous supplies and expenses,	345 88	
		23,298 19
Alewife Brook pumping station: —		
Labor,	\$8,541 99	
Fuel,	1,493 59	
Oil and waste,	194 31	
Water,	148 92	
Packing,	10 40	
Repairs and renewals,	167 17	
Telephones,	29 21	
General supplies,	38 63	
Miscellaneous supplies and expenses,	92 20	
		10,716 42
Sewer lines, buildings and grounds: —		
Engineering assistants,	\$3,000 00	
Labor,	32,944 90	
Automobiles,	855 80	
Brick, cement and lime,	443 94	
Castings, ironwork and metals,	421 68	
Freight, express and teaming,	1 03	
Fuel and lighting,	56 58	
Jobbing and repairing,	289 23	
Lumber,	1,114 19	
Machinery, tools and appliances,	702 74	
Paints and oils,	404 13	
Rubber and oiled goods,	158 34	
Sand, gravel and stone,	230 25	
Telephones,	31 95	
Traveling expenses,	572 39	
General supplies,	903 07	
Miscellaneous expenses,	148 48	
		42,278 20
Horses, vehicles and stable account,		4,390 79
Restoration East Boston screen-house (chapter 775, Acts of 1914): —		
Engineering,	\$529 50	
Labor,	923 90	
Tools, machinery and appliances,	472 01	
Brick, cement and other supplies and expenses,	761 08	
		2,687 39
Contracts: —		
J. Caddigan Co., Contract 121, for building new screen-house at East Boston pumping station,		2,974 37
Payments under Industrial Accident Law and special benefit appropriations,		5,530 44
Total for North Metropolitan System,		\$174,123 78

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1915.
<i>South Metropolitan System.</i>	
Administration:—	
Commissioners,	\$2,041 67
Secretary and assistants,	2,419 82
Rent,	189 37
Heating, lighting and care of building,	187 26
Postage,	60 00
Printing, stationery and office supplies,	593 68
Telephones,	27 40
Traveling expenses,	5 00
Miscellaneous expenses,	33 31
	<hr/>
	\$5,557 51
General supervision:—	
Chief engineer and assistants,	\$4,553 27
Rent,	568 13
Heating, lighting and care of buildings,	561 86
Printing, stationery and office supplies,	279 11
Telephones,	82 20
Traveling expenses,	78 82
Miscellaneous expenses,	14 80
	<hr/>
	6,138 19
Ward Street pumping station:—	
Labor,	\$23,339 57
Fuel,	11,203 08
Oil and waste,	219 39
Water,	1,470 00
Packing,	89 59
Repairs and renewals,	3,044 03
Telephones,	52 87
General supplies,	857 91
Miscellaneous supplies and expenses,	298 25
	<hr/>
	40,574 69
Quincy pumping station:—	
Labor,	\$8,384 43
Fuel,	1,622 98
Oil and waste,	62 75
Water,	208 58
Packing,	54 63
Repairs and renewals,	235 35
Telephones,	26 36
General supplies,	283 48
Miscellaneous supplies and expenses,	30 47
	<hr/>
	10,909 03
Nut Island screen-house:—	
Labor,	\$8,832 58
Fuel,	1,650 47
Oil and waste,	84 18
Water,	324 93
Packing,	10 55
Repairs and renewals,	109 22
	<hr/>
Amounts carried forward,	\$11,011 93 \$63,179 42

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1915.
<i>Amounts brought forward,</i>	\$11,011 98 \$63,179 42
<i>South Metropolitan System — Con.</i>	
Nut Island screen-house — <i>Con.</i>	
Telephones,	65 76
General supplies,	476 09
Miscellaneous supplies and expenses,	65 68
	11,619 46
Sewer lines, buildings and grounds: —	
Engineering assistants,	83,337 50
Labor,	18,423 24
Automobiles,	945 65
Brick, cement and lime,	52 80
Castings, ironwork and metals,	59 56
Fuel and lighting,	81 38
Jobbing and repairing,	22 01
Lumber,	417 63
Machinery, tools and appliances,	194 40
Paints and oils,	35 26
Rubber and oiled goods,	80 73
Sand, gravel and stone,	13 20
Telephones,	48 55
Traveling expenses,	434 85
General supplies,	243 25
Miscellaneous expenses,	92 33
	24,532 33
City of Boston, for pumping and interest,	6,423 73
Horses, vehicles and stable account,	3,110 76
Total for South Metropolitan System,	\$108,885 70

(b) Receipts.

The receipts from the sales of property, from rents and from other sources, have been credited as follows:—

ACCOUNT.	For the Year ending December 31, 1915.
Construction: —	
North Metropolitan System,	\$153 27
South Metropolitan System,	4,978 13
Maintenance: —	
North Metropolitan System,	559 53
South Metropolitan System,	152 33
Amount credited from beginning of work to January 1, 1915,	\$5,843 26
Total receipts to January 1, 1916,	120,888 01
	\$126,728 27

(c) *Assets.*

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board:—

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; completed works, real estate connected therewith.

(d) *Liabilities.*

There are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
High-level sewer:—		
National Contracting Co., . . .	Section 73, Contract abandoned,	\$5,516 17 ¹
High-level sewer extensions:—		
Timothy J. O'Connell,	Section 82, in part, Contract 57,	60 00
W. H. Ellis & Son Co.,	Section 43, in part, Relief Outfall line, Contract 120,	5,255 85
Hugh Nawn Contracting Co.,	Contract 123, Section 106, Wellesley extension,	2,646 04
Hugh Nawn Contracting Co.,	Contract 124, Section 105, Wellesley extension,	4,463 07
North System enlargement:—		
George M. Bryne,	Contract 131, Section 1A, Deer Island Outfall extension,	415 15

¹ Damages claimed by the Commonwealth on account of the abandonment of the contract exceed this amount.

Claims have been made by the following parties for land taken and other damages, and suits are now pending in the courts for the determination of many of them:—

Anna L. Duncan, Carrie S. Urquhart, N. Jefferson Urquhart, Edwin N. Urquhart, Richard Jones, James Doherty, Michael Niland, William H. Gibbons, Francis Normile, Boston & Maine Railroad, Isabella P. Shaw, Arthur W. Pope, F. Murray Forbes, Hugh D. Scott, Mabel H. Foster, Walker-Gordon Laboratory Co.

VIII. RECOMMENDATIONS FOR LEGISLATION.

In the abstract of the annual report for the year 1915 the Board made the following statement and recommendations:—

The question of the disposal of the electric energy developed at the Wachusett power plant after October 1, 1916, when the existing contract expires, should receive early attention, as it is possible that it may be for the best interests of the Metropolitan Water District to connect the Wachusett and Sudbury power plants by a transmission line.

This arrangement would increase the reliability of the service, and if a contract for the disposal of the energy is made early in the year, so as to allow time for the construction of the transmission line before October 1, the energy could be sold for delivery at either the Wachusett power plant in Clinton or at the Sudbury power plant in Southborough, as may be found to be most desirable.

The transmission line would be about 15½ miles in length, and could be located on the Wachusett Aqueduct and Sudbury Reservoir lands for the entire distance, with the exception of crossings over highways and railroads. An alternative location over private lands for a distance of 900 feet would be more desirable from a construction standpoint, provided satisfactory arrangements can be made for the acquisition of the rights required.

The estimated cost of a two-circuit underground cable line for a distance of 700 feet from the Wachusett power station and a one-circuit overhead transmission line on expanded steel truss poles for the remainder of the distance is \$60,000.

To provide for the satisfactory operation of the Weston Aqueduct supply mains when the Sudbury power plant is put into operation, some additional valves and connections should be installed between these mains and the low-service mains at Chestnut Hill Reservoir in Brighton and at Coolidge Corner in Brookline, and some of the meters on the mains in Brookline, which were acquired from the City of Boston, should be relocated at the Boston boundary line.

With the present arrangement of the meters on the low-service mains in Brookline and Somerville, which were recently acquired from the City of Boston, the city is charged with any leakage which may be taking place from these mains, which are now the property of the Board, and in order to remedy this condition it will be necessary to relocate all of the meters at the Boston boundary line.

The estimated cost of making these connections and relocating all of the meters is \$35,000.

The service furnished to the higher portions of Hyde Park and Milton through the existing 12-inch main has not been entirely satisfactory at times during the past year, because of the interruption of the regular service due to the use in common by the Boston Water Department and this department of the section of the line about 2,200 feet in length, located in Poplar Street, West Roxbury, which belongs to the City of Boston, and to a leak which occurred in the single line of flexible jointed pipe under the Neponset River, which required ten days for repairs. During this period the supply was maintained through the city of

Boston pipes by pumping to its standpipe on Fairmount in Hyde Park. The disposal of this standpipe and the reservoir at its base has been under consideration by the city, and if the standpipe should be abandoned, a second pipe line should be laid in Poplar Street, West Roxbury, and under the Neponset River, to insure a reliable service for the Milton and Hyde Park extra high-service district.

The estimated cost of laying a separate 12-inch pipe line for the department in Poplar Street and another flexible jointed 12-inch pipe line under the Neponset River is \$7,000.

When the northern extra high-service supply was introduced into Arlington in 1899, the town granted this department the right to use in common with the town of Arlington the water pipes belonging to the town, so far as necessary, for the purpose of conveying water into the standpipe and to the town of Lexington. Satisfactory service is not now furnished by the use of the Arlington mains in common, and it seems desirable to lay a 16-inch Metropolitan Water Works main from the standpipe to the Lexington boundary line, a distance of about 6,000 feet, during the present year, provided the pipe can be purchased at a reasonable price.

When the new Arlington pumping station was built in 1907 an Allis-Chalmers high-duty, horizontal cross-compound fly-wheel type pumping engine, having a capacity of 1,500,000 gallons per day, was installed for regular service, and a low-duty, horizontal, duplex-compound, direct acting Blake & Knowles pumping engine, having a capacity of 1,500,000 gallons per day, was installed for emergency service.

During the hot, dry weather in summer the consumption of the northern extra high-service district is at the rate of over 2,500,000 gallons per day at times, and satisfactory service cannot be furnished by the present equipment because of the large amount of steam required to operate the Blake pump and the numerous complaints received when this pump is in operation, of water hammer in the pipe lines. If the Allis engine should be out of service for any reason during this season of maximum consumption, the supply could not be maintained with the Blake pump. Under these conditions it seems to be desirable to provide for the removal of the Blake pump and the installation of a new pumping engine at this station.

The estimated cost of these improvements is \$48,000, of which about one-half is for the pipe line.

There is a balance of \$196,000 now remaining from the appropriation of \$600,000 authorized by chapter 694 of the Acts of 1912 for the purchase of certain property from the City of Boston, and it is recommended that authority be given to issue bonds under this appropriation from time to time as may be required for the above projects to a total amount not exceeding \$150,000, subdivided as follows: —

Transmission line, Wachusett power station to Sudbury power station,	\$60,000 00
Connections and relocations of meters for Low Service district,	35,000 00
Improvements in Southern Extra High Service pipe line,	7,000 00
Improvements in Northern Extra High Service works,	48,000 00
	<hr/>
	\$150,000 00

When the City of Boston took Cochituate Lake as a water supply it also acquired the outlet to Dudley Pond, containing 1 acre and 30 rods, and took possession of its waters. This pond lies in a northeasterly direction from the northern division of the lake, and contains 81 acres at an elevation of about 12 feet above the lake.

The waters of this lake when first taken were pure and soft, and the pond was connected with the lake in the year 1861, thirteen years after the introduction of water into the city of Boston. For a number of years the territory about this pond was unoccupied, and there was no probable pollution of its waters from human habitation. Inasmuch as the city owned nothing but a small portion of land immediately about the outlet of the pond, it had no means of protecting itself against the occupation of its shores. The attractive nature of the pond has in recent years brought many summer residents, who have established themselves in some cases upon the very margin of the pond. It will only now be possible to avoid the dangers of pollution from household waste by very extensive purchases of land and houses, which the value of the waters of this small pond does not in the opinion of the Board justify. The waters of this pond have not been used for a number of years, and the Board is of the opinion that it will not be safe in the future to use this as a source of domestic water supply.

The Board, therefore, recommends that this pond be detached from the Metropolitan Water Supply and restored to its original condition.

The pumping plant at the Ward Street Sewerage Pumping Station has been in operation over ten years, and both engines and boilers are beginning to show the results of service. The pumping engines each have a capacity of about 50,000,000 gallons per day. In flood periods it is necessary to run both of the engines. On account of this condition it is necessary that both of these engines shall always be kept in condition for immediate use. This so far has been successfully accomplished as all repairs have been made in such manner that the engine has been left in condition for service for the night shift, if necessary.

The most important repairs so far on these engines have been in the valves, but the moving parts, such as main bearings and other heavy parts, have never been repaired and probably soon will need attention. In such case it would be impossible to make these repairs in such manner as to keep the two engines in readiness for service.

At the time of the erection of this plant, foundations were prepared for a third engine of the same type. These engines cost about \$225,000, including boilers. The boiler plant probably had a cost of about \$25,000, so that these engines alone cost in the neighborhood of \$100,000 each.

Since the completion of this station the steam turbine engine has been greatly improved, and there are numerous turbine driven centrifugal pumps in use which are giving satisfactory service. The foundation already constructed at this plant would be entirely suitable for the installation of such a turbine driven pump.

Several plants of this type have been examined, and it is believed that such a pump would be satisfactory for our needs. It is estimated that one could be installed at this station for about \$20,000, not including piping. While the centrifugal pump is not as efficient and economical as the high-duty pumps in service at this station, yet there is much to be said on the side of the centrifugal for

pumping sewage. At present there is a large expenditure for valve repairs which would be entirely eliminated on the other type; also oil, packing and other supplies would be very much less.

The boilers in this station, of which there are four, are of the Dean type, vertical, internally fired. The service of the station requires that at least two of these boilers should be in continuous operation, leaving a duplication under ordinary circumstances. After ten years of service, however, these boilers are showing signs of wear, and there have been several times when repairs have been going on in two of these boilers, leaving at such a time no duplication whatever.

The Board recommends that two additional boilers of the same type as those existing should be added to the plant. These will cost about \$12,000, exclusive of piping. It is believed that \$40,000 would be a sufficient sum to cover the expense of the installation of such additions as are necessary at the Ward Street Pumping Station, and it is recommended that authority be given to issue Sewerage Loan bonds to the amount of \$40,000 for that purpose.

The detailed reports of the Acting Chief Engineer of the Water Works and of the Engineer of the Sewerage Works, with various tables and statistics, are herewith presented.

Respectfully submitted,

HENRY P. WALCOTT,
EDWARD A. McLAUGHLIN,
THOMAS E. DWYER,
Metropolitan Water and Sewerage Board.

BOSTON, February 26, 1916.

REPORT OF CHIEF ENGINEER OF WATER WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN:— I have the honor to submit the annual report of the work done under the direction of the Chief Engineer of Water Works in connection with the construction, maintenance and operation of the Metropolitan Water Works for the year ended December 31, 1915.

ORGANIZATION.

Since the death of Mr. Dexter Brackett, Chief Engineer, on August 26, the work has been under the direction of the Acting Chief Engineer, with principal assistants as follows:—

Elliot R. B. Allardice,	Superintendent of Wachusett Department.
Charles E. Haberstroh,	Superintendent of Sudbury Department.
Samuel E. Killam,	Superintendent of Distribution Pipe Lines and Reservoirs.
Arthur E. O'Neil,	Superintendent of Distribution Pumping Stations.
Alfred O. Doane,	Division Engineer, in charge of Mechanical Engineering and Inspection Work.
Burdett C. Thayer,	Chief Electrician.
William W. Locke,	Sanitary Inspector.
Clifford Foss,	Assistant Engineer in charge of Construction Work.
Benjamin F. Hancox,	Assistant in charge of Drafting.
James W. Killam,	Assistant Engineer in charge of Coal and Oil Testing.
William E. Whittaker,	Office Assistant.
Charles E. Livermore,	Biologist.

Including these principal assistants the number of supervising, engineering and clerical employees has averaged 51 during the year.

In addition to the above force the number of employees engaged in maintaining and operating the reservoirs, aqueducts, pipe lines, power plant and pumping stations and doing minor construction work has been as follows:—

DEPARTMENT.	Beginning of Year.	End of Year.	Maximum.	Average.
Wachusett,	42	45	73	55
Sudbury,	55	58	65	58
Distribution, pipe lines and reservoirs, . . .	82	80	109	88
Distribution, pumping stations, . . .	57	55	56	55
	236	236	303	256

CONSTRUCTION.

WATER PIPE TUNNEL UNDER CHELSEA CREEK.

The construction of a 42-inch cast-iron water main, by tunnelling under Chelsea Creek between Chelsea and East Boston, to provide for the deepening of the ship channel by the United States Government, was almost completed at the close of last year under a contract with Coleman Brothers, of Chelsea. The connections with existing pipe lines on the shores of the creek having been completed, the new pipe line was put into service on January 9. It replaces two 24-inch flexible-joint pipe lines, one laid in 1870 by the city of Boston and the other in 1900 by this department, which were formerly used for supplying water to the East Boston low-service district.

The old pipe lines, which were buried about five feet below the bottom of the channel, were removed without excavating a trench, by pulling them up in sections with a large wrecking lighter equipped with a derrick having a boom 95 feet in length. The sections usually included two or three pipes but on one occasion seven pipes were pulled up at one lift. The derrick sling was placed around the pipes by a diver who made the necessary excavation for this purpose with a jet of water supplied from a pump on the lighter.

The entire work of constructing the new line and removing the old lines was completed February 20. The total expenditure for this work is \$80,487.33, of which \$25,257.67 was expended during the year.

ADDITIONAL 24-INCH MAIN FROM DORCHESTER LOWER MILLS TO QUINCY.

The work of laying a second 24-inch cast-iron southern high-service main about 13,000 feet in length from Dorchester Lower Mills through Washington Street, and Adams Street, Milton, to Quincy, to reinforce the 24-inch main laid in 1897 and 1898 was resumed on April 16 under the contract with John J. Evans of Lawrence. Work was completed on August 5 under this contract, which included all of the pipe line with the exception of the crossings over the Neponset River and the New York, New Haven & Hartford Railroad.

At both of these crossings steel pipes were used instead of cast iron as it was desirable to reduce the weight of the pipe line and the space occupied as much as possible so that the pipe line could be supported by the existing bridges.

It was originally planned to connect the new 24-inch pipe line with the Metropolitan Water Works 36-inch main at the junction of Morton and River streets in Dorchester, where the old 24-inch main connects, but in order to provide for an emergency supply in case of accident to the 36-inch main, the portion of the Boston Water Works 36-inch main 461 feet in length, located in Sanford Street between Morton Street, where it connects with the Metropolitan Water Works 36-inch main, and Washington Street, where a supply could be obtained from the Boston mains, was purchased from the city of Boston August 3 for \$4,216.62. The new 24-inch main was then laid from the junction of River and Washington streets, through Washington Street to Sanford Street and connected with the 36-inch main purchased from the city, instead of through River Street to connect with the 36-inch Metropolitan Water Works main in Morton Street, as originally planned.

Under the contract with John J. Evans 2,714 feet of 24-inch pipe line has been laid during the year, making a total length of 12,564 feet laid under this contract. The force employed by the contractor averaged about 28 and reached a maximum of 49 men.

The pipe and specials for the pipe line were delivered to the contractor and loaded on his wagons by the department force at the Norfolk Downs pipe yard, located about 1.6 miles from the pipe line.

The expenditures for the work done during the year amount to \$7,013.39, making a total of \$20,795.62 under this contract.

The 24-inch steel pipe line at the crossing over the Neponset River is 134 feet in length, is located below the floor of the highway bridge and is supported at the ends by the bridge abutments and at four intermediate points by steel I beams which are supported on the bridge piers. The construction of the wooden box to protect the pipe from frost was in progress at the close of the year.

At the railroad crossing it was necessary to remove the double line of 16-inch cast-iron pipes forming a portion of the existing main, in order to obtain space for the two lines of 22-inch steel pipe which have been laid beneath the sidewalk of the highway bridge over the railroad. The combined lengths of the two lines of steel pipe at this crossing, including the 45° elbows at the ends, is 76.6 feet. One line replaces the double line of 16-inch pipes which was removed, and the other forms a portion of the new main. The bridge abutments form the entire supports for these steel pipes, which are enclosed in a tight box to protect them from frost and the corrosive action of the smoke from the locomotives. The sidewalk planks form the top, the 12-inch steel bridge floor beams with wooden stringers on top form the sides, and 2-inch wooden plank resting on the bottom flanges of the steel beams form the bottom of the pipe box. A temporary 24-inch cast-iron pipe line was laid over the railroad bridge to provide for the flow of water while the work of laying the steel pipes was in progress.

Walsh's Holyoke Steam Boiler Works constructed the steel pipes, painted them at the shop one coat on the exterior and two coats on the interior with genuine red lead and linseed oil paint furnished by the department, and laid them in position at the bridges for the sum of \$850 for the river crossing and \$750 for the railroad crossing.

The pipes are made of open hearth flange steel plates $\frac{3}{8}$ of an inch in thickness and $\frac{7}{8}$ of an inch diameter rivets, with alternate inside and outside courses, double-riveted lap longitudinal seams and single-riveted lap girth seams.

After the pipes were laid and tested the W. L. Waples Company for the sum of \$79.20 painted the interior and exterior surface with one coat of red lead paint furnished by the department.

For testing the steel pipes caps were bolted on the ends and the joints were made with wooden staves to facilitate the removal of the caps after the pipes were tested.

On account of the limited space available in the streets the old pipe line was cut at four points and the ends of the sections were

connected with sections of the new main by the department forces to avoid crossing the lines. As a result, both the easterly and westerly lines now include sections of the old and of the new mains. Both lines have been in service since September 13. A connection was made with the Milton Water Works mains at Randolph Avenue on July 15, and the connection between the 36-inch main purchased from the city of Boston and the new 24-inch main was made on August 19. Both in Boston and Milton the pipe trenches were resurfaced by the local highway forces by agreement. Including the work done in 1914 and in 1915 the cost of the resurfacing is \$926.24 or \$0.70 per linear foot in Boston, and \$2,778.87 or \$0.26 per linear foot in Milton.

The total expenditure for the new 24-inch main is \$77,498.76, of which \$29,131.45 was expended during the year.

EXTENSION OF 20-INCH FORCE MAIN IN WEST ROXBURY.

The extension of the southern extra high-service 20-inch force main from the junction of Beech and Poplar streets to the Bellevue Reservoir in West Roxbury, which was laid in 1914, was tested and was put into service January 28. The total expenditures on account of this extension amount to \$23,386.79, of which \$1,460.46 was expended during the year.

BELLEVUE RESERVOIR.

Steel Tank.

The construction of the concrete foundation and erection of the steel tank for the southern extra high-service reservoir on Bellevue Hill in West Roxbury were completed in 1914. The steel tank, which is 100 feet in diameter and 44 feet 3 inches in height and has a capacity of 2,500,000 gallons, was filled with water to a depth of 6 inches above the crest of the overflow weir and tested for leakage on January 9. The water was then drawn out and a number of cracked and leaky rivets were replaced. This work was completed on January 22, and as the weather conditions were then unfavorable for sand blasting and painting the steel, the tank was again filled and put into service. On March 25 the tank was taken out of service and drained and the work of sand blasting and painting the steel was begun March 30 by the W. L. Waples Company of Boston, sub-

contractor for this work. The plant used consisted at first of a 20-horse power, gasoline engine driven air compressor, a compressed air reservoir, two lines of air hose and two nozzles. Sand blasting was stopped in the latter part of the afternoon of each day and the cleaned surfaces were painted before rusting commenced. The force employed included 1 foreman, 2 painters, who also did sand blasting, and 1 helper. This force could sand blast and paint an area of about 330 square feet per day. Later, in order to increase the rate of progress, a second compressor, operated by an automobile engine, was installed on April 19. The entire inside and outside surface of the tank, having an area of 35,650 square feet, was sand blasted and painted. Work was completed June 14, with the exception of the third coat on the outside, which has been deferred until after the masonry tower which encloses the tank is completed. All painting materials were furnished by the department, but were mixed by the contractor under the direction of the engineer. For the inside of the tank National Lead Company's red lead in oil paste, litharge and Spencer-Kellogg & Son's boiled linseed oil were used; the first coat natural color, the second and third coats tinted with lamp black in oil. For the outside of the tank red lead paste, raw linseed oil and drier were used for the first coat, and for the second coat white lead, raw linseed oil, turpentine and drier tinted with lamp black were used. One gallon of red lead paint was sufficient to cover 700 square feet of surface with one coat. The sub-contractor's price for sand blasting and painting the tank was \$1,600, of which \$50 has been reserved until the third coat of paint is applied to the outside of the tank. The total expenditure for the steel tank is \$16,992.59, of which \$2,999.94 was expended during the year.

Masonry Tower.

A contract for the construction of the masonry tower which encloses the tank and protects the water from frost was made with the John Cashman & Sons Company April 23 for the sum of \$46,000.

The tower is 114 feet 2 inches in outside diameter at the base and 108 feet 2 inches in inside diameter. It is 47 $\frac{1}{2}$ feet in height from the concrete foundation to the top of the cornice. A parapet wall 4 feet in height above the cornice surrounds the roof. There is a central hexagonal turret 70 feet across on the diagonal with a pyramidal roof the apex of which is 16 feet above the cornice.

There are two entrances to the tower. The front entrance faces the north and the rear entrance the southeast. The front entrance is 9 feet above the base of the tower and the rear entrance on a level with the base and opposite the manhole in the steel tank.

Three feet above the water table there are 11 windows spaced equally around the tower, and there are 4 small windows in the stairway leading from the front entrance to the roof. Just below the cornice, spaced equally around the tower, are 12 groups of 5 windows each.

The tower is of Bay View gray Rockport granite backed with concrete, with the exception of that portion of the tower which extends below the surface of the ground, which is entirely of concrete. A rough-pointed band course 24 inches in height encircles the tower 10 feet above the base. Below this band the tower is of rock-face coursed ashlar, and above of rock-face broken-range ashlar, with the exception of the cap and sill stones of the upper windows and the caps and sills of the lower and stairway windows, the upper course of the cornice, the coping of the parapet and arch over the front entrance, all of which are rough pointed. The lower course of the cornice is six-cut work.

The roof framing consists of steel trusses and beams which are supported on the masonry wall and on six steel columns set inside the steel tank. The turret roof is of dull green Imperial German roofing tiles laid directly on steel purlins. The remainder of the roof is of reinforced concrete slabs supported on steel I beams and covered with a layer of reinforced Neuchatel asphalte 1 inch in thickness. The turret walls are 4 feet 6 inches in height of 4-inch x 12-inch hollow terra cotta blocks with a 1-inch facing of cement plaster and a reinforced concrete cornice. An iron stairway, located between the steel tank and the wall of the tower, leads from the front entrance up to the roof and down to the base of the tower. There is a granolithic floor between the steel tank and the masonry wall.

The only inflammable and perishable materials used in the entire structure are the wooden window frames and six ridge boards for the turret roof.

The contractor began work promptly but, owing to delays due to resurfacing a large portion of the cut stone and to a fire on November 29 which destroyed the contractor's office and store-house, the work was not completed at the close of the year.

On September 30 the steel tank was drained to give the contractor an opportunity to construct the roof of the tower. The work remaining to be done consists of laying the asphalte and tiles on the roof, plastering the turret walls, laying the granolithic floor between the steel tank and the masonry wall, painting and cleaning up.

The plant used during construction consisted of 4 steam stiff-leg derricks with booms 62 to 84 feet in length, a $\frac{1}{2}$ -cubic yard capacity Smith concrete mixer and miscellaneous small tools. The concrete forms were made of wood.

The force employed averaged 30 and reached a maximum of 38 men.

The expenditures under this contract amount to \$34,109.51, and the value of the work done at the close of the year is \$41,000.

EXTENSION OF 60-INCH WESTON AQUEDUCT SUPPLY MAIN IN NEWTON.

In November, 1914, contracts were made with the United States Cast Iron Pipe & Foundry Company at very favorable prices for the 60-inch cast-iron water pipes and specials required for extending the 60-inch Weston Aqueduct supply main laid in 1909 and 1910, through Commonwealth Avenue in Newton, from a point 700 feet east of Prince Street to the Charles River, a distance of about 14,500 feet. Under these contracts 6,855.70 tons of 60-inch pipe and 258.38 tons of specials were delivered at a cost of \$147,109.64.

A contract was made with Andrew M. Cusack of Boston for laying 7,990 linear feet of the pipe line east of Auburn Street on April 30, and another contract was made with Charles A. Kelley of Somerville May 18 for laying the remainder of the line, with the exception of the crossing under the Boston & Albany Railroad, where a 60-inch steel pipe was laid.

Mr. Cusack began work at the easterly end of his section May 20 and for the following four months the progress was unsatisfactory, due to the failure of the contractor to push the work. Later, when arrangements were made to increase the progress, there was considerable difficulty in obtaining workmen, and as a result there remained 144 linear feet of pipe line to be laid under this contract at the close of the year. The force employed averaged about 72 men and 11 horses and reached a maximum of 98 men and 15 horses. At the close of the year 7,821 linear feet of 60-inch pipe line had

been laid and 1,868 cubic yards of rock had been excavated. The 60-inch pipe line is located parallel with the 48-inch pipe line laid in 1902, with a space of only a few feet between the lines, and great care was necessary in blasting to prevent injury to the 48-inch main. In earth excavation the pipe trench was excavated with pick and shovel and the material was loaded into buckets and hoisted and dumped into carts with portable steam derricks. In the easterly portion of the work considerable difficulty was experienced on account of the large amount of ground water that entered the trench. The expenditures under this contract amount to \$40,597.13, and the total value of the work done is \$47,900.

Mr. Kelley began work May 24 at Auburn Street and completed his entire contract December 11, about two months later than the date specified in the contract. A connection was made between the new main and the 48-inch main at the Charles River on October 16. In earth excavation trenches were excavated with pick and shovel and the material was hoisted in buckets and dumped into carts with portable steam derricks. The force employed averaged 62 men and 8 horses and reached a maximum of 84 men and 10 horses. Under this contract 6,376 linear feet of 60-inch pipe line was laid and 592 cubic yards of rock was excavated. The expenditures under the contract amount to \$27,633.62, and the value of the work done is \$33,349.56.

The pipes and specials for both of the pipe-laying contracts were delivered to the contractors and loaded on their wagons by the department forces at the Woodland pipe yard, located about one mile from the pipe line.

By agreement, the resurfacing of the pipe trench for the entire distance is being done by the city of Newton Highway Department with its regular forces. At the close of the year 10,400 linear feet of trench had been resurfaced at a cost of \$18,436, equivalent to \$1.77 per linear foot of trench.

At the bridge over the Boston & Albany Railroad the 60-inch pipe line was offset and laid down the embankments and under the railroad tracks south of Commonwealth Avenue in private land. For a distance of 86 feet, where located under the railroad tracks, a 60-inch steel pipe was laid. This pipe is made of open hearth flange steel plates $\frac{5}{8}$ of an inch in thickness and 1 inch rivets, with alternate inside and outside courses, with butt and double-strap double-riveted longitudinal seams and single-riveted lap girth seams.

By arrangement with the Boston & Albany Railroad Company its forces excavated and sheeted the trench for the pipe under the railroad, and placed under each rail three 15-inch steel beams 20 feet in length supported at each end on two 12-inch x 12-inch hard pine mud sills to support the trains over the trench while the pipe was being laid. This work was begun April 11.

Walsh's Holyoke Steam Boiler Works constructed the steel pipe and laid it in position in the trench under the tracks for the sum of \$1,720. Arrangements were made for the testing and painting of this pipe similar to the arrangements followed in connection with the steel pipes for the 24-inch southern high-service pipe line. The final painting of the 60-inch pipe was done by Hemphill & Soulis of Newton for the sum of \$20. After the pipe was tested and painted the trench was filled with concrete, which was carried over the top of the pipe to a depth of 6 inches, by the department forces. About 78 cubic yards of concrete were placed and the pipe was kept full of water under pressure while the work was in progress.

The cost of the work done by the Railroad Company was \$1,581.99 and the cost of the work done by the department forces was \$997.88, which, with the cost of the pipe and laying, is equivalent to \$50 per linear foot.

The pipe line crosses under four main line tracks at this place, and except that for a portion of the time the speed of the trains was reduced to 15 miles per hour while crossing the trench, the regular train service was maintained without interruption while the work was in progress. The work was completed May 22.

SUDBURY POWER PLANT.

In 1914 plans and specifications were prepared for the construction of a hydro-electric plant to utilize the water power available at the Sudbury Dam in Southborough, and a contract was made with the Edison Electric Illuminating Company of Boston December 21, 1914, for the purchase of electric energy to be developed.

Specifications for the hydro-electric machinery were sent to the leading manufacturers of this type of machinery January 4. The machinery is to be installed in the existing gate-house at the north-easterly end of the spillway of the Sudbury Dam. The gate-house was not designed for use as a power-house and its use for this purpose requires that the water wheels shall be installed under very unusual

hydraulic conditions. Because of the necessity of discharging the water from the wheels through long pipe lines at high velocity, trouble from hydraulic surges was anticipated by the manufacturers and they were unwilling to make any definite guarantee of efficiency based on tests after installation.

With one exception all the manufacturers from whom bids were requested declined to submit proposals. The invitations for proposals were therefore withdrawn on January 27. The plans and specifications were then modified in several particulars to provide for the construction of a surge tank near the outlet of each turbine and the furnishing of the hydraulic governors by the Commonwealth, for testing the turbines at the Holyoke testing flume instead of in place, and for receiving proposals for either the hydraulic or the electric machinery or for both.

Proposals were received under the revised plans and specifications June 11. The proposal of the S. Morgan Smith Company of York, Pennsylvania, to furnish and install the hydraulic machinery for the sum of \$11,760, and of the Westinghouse Electric & Manufacturing Company of Pittsburgh, Pennsylvania, to furnish and install the electrical apparatus for the sum of \$19,349, were accepted, and contracts were made with these companies on June 23.

The plant will consist of one 30-inch, 1,000-horse power, and two 24-inch, 300-horse power, vertical-shaft hydraulic turbines directly connected to one 900-kilo-volt-ampere and two 275-kilo-volt-ampere alternating-current generators. Two 125-volt direct-current generators, each of sufficient capacity to furnish excitation for the three main generators when under maximum load are provided, one directly connected with an electric motor, the other directly connected to the top of the shaft of the 900-kilo-volt-ampere generator.

The 30-inch turbine will be operated by the water discharged into Framingham Reservoir No. 3 and the two 24-inch turbines by the water discharged into the Weston Aqueduct. The units will operate at a speed of 360 revolutions per minute and deliver 3-phase, 60-cycle alternating current at a pressure of 2,400 volts, which will be stepped up by two 750-kilo-volt-ampere transformers to 13,200 volts for transmission for a distance of about three-fourths of a mile to the transmission line of the Company.

For a distance of 730 feet from the power-house, to an existing

granite building used for a store-house, the transmission line will be located under ground near the top of the dam in a conduit. The store-house is being remodelled so that a portion can be utilized as a lightning arrester chamber. Two underground cables, each of sufficient capacity to carry the entire output from the station, will be laid in the underground conduit between the power-house and the lightning arrester chamber, and from the latter point a single overhead line is being constructed for a distance of about 4,000 feet to connect with the Company's line on Brewer Road in Framingham near the Southborough boundary line.

The turbines were tested at the Holyoke testing flume October 22 to 27. The 30-inch turbine developed an average efficiency of 87.4 per cent. or 2.58 per cent. in excess of the guarantee. The 24-inch turbine developed an efficiency of 85.3 per cent. or 1.15 per cent. in excess of the guarantee.

One of the 24-inch turbines and a portion of the 30-inch turbine were shipped to the power-house from the manufacturer's works at York, Pennsylvania, December 28.

The electric generators were tested at the manufacturer's works at East Pittsburgh, Pennsylvania, between October 19 and 27, with satisfactory results, and are now being held at the works until the installation of the turbines is further advanced.

An agreement was made with the Lombard Governor Company of Ashland, Massachusetts, for three horizontal-type hydraulic governors for the turbines on July 21 for the sum of \$2,404, and they have been built and are ready for delivery when required. One of the governors is of 6,000 foot pounds capacity and the other two are each of 2,500 foot pounds capacity. The equipment includes electric-driven rotary oil pump, with capacity of 15 gallons per minute, a pressure tank and a sump tank and unloading valve of sufficient capacity to serve all three governors.

The work of constructing the surge tanks and enlarging the wells in the existing gate-house to provide for the turbines was begun early in June. The surge tanks for the Weston Aqueduct service are 15 feet long, $7\frac{1}{2}$ feet wide and 7 feet high; the one for the Framingham Reservoir No. 3 service is of irregular shape, about 10 feet long, 6 feet wide and 13 feet high. A 6-inch galvanized iron air pipe and a $1\frac{1}{2}$ -inch brass observation pipe are carried up from each tank and end just below the power-house floor, a few feet above high-water

line in the reservoir. The 6-inch pipes are provided with valves for regulating the flow of air as desired.

The two surge tanks on the Weston Aqueduct service are connected with the outlet conduits just below the draft tubes of the 24-inch turbines, by means of 30-inch cast-iron pipes, with diaphragms at the surge tank ends having openings 21 inches in diameter. A connection between the surge tank on the Framingham Reservoir No. 3 service and the 48-inch outlet pipe below the draft tube of the 30-inch turbine is made by means of a 24-inch branch with a bell mouth end extending into the surge tank.

This work involved the excavation of 400 cubic yards of brick and stone masonry in the existing dam and gate-house and the placing of 250 cubic yards of concrete; the removal of 50 feet of 48-inch cast-iron pipe and the laying of 15 tons of 30-inch to 64-inch diameter cast-iron pipe and specials.

It was necessary to do a large portion of this work by electric light at the bottom of the three outlet wells at the gate-house at a depth of about 60 feet below the surface of the water in the reservoir, while maintaining a flow of about 100,000,000 gallons per day through the gate-house for water supply.

Under these conditions it was deemed advisable to make the excavations with unusual care and without the use of explosives. An agreement was therefore made with Coleman Brothers, of Chelsea, to furnish the plant required at a specified daily rental and to furnish the necessary experienced labor at cost plus 10 per cent.

The plant used consisted of a 90-horse power locomotive-type boiler and a 50-horse power Ingersoll-Rand air compressor, a stiff-leg boom derrick and hoist, one 6-inch centrifugal and two 3-inch reciprocating pumps, a blacksmith's outfit and the necessary drills, air hose and small tools required for the work.

In order to reduce the plant charges and to obtain the desired progress, the work was carried on continuously in three 8-hour shifts, with the exception of Sundays and holidays, until November 20, when the bulk of the work was completed. Until this time the force averaged 52 men, and reached a maximum of 70 men.

The plant was then dismantled and the work of cutting channels and pockets in the masonry walls of the turbine wells for the gate shafts and steady bearings and the steelwork foundations for the generators was completed with a portable air compressor operated

by a gasoline engine. The force employed on this portion of the work averaged 11 men.

During October a hand-operated traveling crane and runway of 12,000 pounds capacity was installed in the power-house by Wonham, Sanger & Bates, of New York, for the sum of \$880.

In remodelling the gate-house to provide for the turbines it was necessary to remove three sluice gates at the outlets from the turbine wells and provide three new sluice gates for controlling the flow of water into the wells. The new sluice gates have a clear opening 11 feet 2 inches high and 5 feet $5\frac{1}{2}$ inches wide, and are provided with two-speed ball-bearing gate stands with limit switches for electrical or hand operation. Each gate is made with an upper and lower leaf and the gate shaft is attached to the lower leaf, which rises first, sliding over composition guide strips on the up-stream face of the upper leaf until its upper edge engages lugs on the top of the upper leaf, when both rise together until the lower part of the leaves are above high water in the reservoir. This unusual construction was made necessary to avoid having the gate come above the floor of the power-house when open. The gates are being constructed by the Coffin Valve Company, of Boston, for the sum of \$3,915. About half of the shop work on the gates is completed at the close of the year.

A contract was made December 2 with the Safety Insulated Wire and Cable Company, of New York, to furnish and install in the underground conduit which has been constructed by the department forces, about 1,550 feet of 3-conductor, paper-insulated, lead-sheathed cable for the sum of \$1,182.61.

Two Type M Venturi indicator recorder registers have been substituted for the old Type D registers on the Venturi meters which measure the flow in the two 60-inch pipe lines leading to the Weston Aqueduct, in order to obtain more accurate measurement of the water under the conditions that will prevail when the hydro-electric plant is in operation.

The total amount expended for the construction of the power plant is \$50,932.51, of which \$50,151.16 was expended during the year.

ENGINEERING.

In connection with the construction work the engineering force has prepared the plans and specifications for contracts and supervised the construction work as required.

MAINTENANCE.

RAINFALL AND YIELD OF WATERSHEDS.

The annual rainfall on the Wachusett watershed was 44.65 inches, which is 0.78 of an inch less than the average for the previous 18 years, but 6.11 inches more than in 1914. On the Sudbury watershed the rainfall amounted to 43.93 inches during the year, which is 0.88 of an inch less than the average for the previous 40 years and 6.22 inches more than in 1914. On the Cochituate watershed the annual rainfall amounted to 44.35 inches.

The large rainfall of about 6.5 inches in January; the extremely small rainfall of 0.06 of an inch on the Wachusett watershed, of 0.05 of an inch on the Sudbury watershed and 0.01 of an inch on the Cochituate watershed in March; the low rainfall in April, May and September and unusually large precipitation during July and August, amounting to 15.50 inches on the Wachusett watershed, are notable departures from the normal precipitation. A total precipitation of 6.42 inches from June 30 to July 3, as measured by our gages at Chestnut Hill Reservoir, in Boston, was an unusual occurrence.

The yield of the Wachusett watershed was 942,000 gallons per day per square mile, which is 88 per cent. of the average for the previous 18 years. The yield of the Sudbury watershed was 719,000 gallons per day per square mile, which is 72 per cent. of the average for the previous 40 years, and 80 per cent. of the average for the previous 18 years, or the period during which water has been discharged into the Sudbury Reservoir from the Wachusett watershed. The yield of the Cochituate watershed was 792,000 gallons per day per square mile, which is 86 per cent. of the average for the previous 52 years.

During the year the city of Worcester has turned into the present Wachusett watershed, from the 9.35 square miles of the former Wachusett watershed taken for its water supply in 1911, 1,342,400,000 gallons of water.

STORAGE RESERVOIRS.

The capacities of the storage reservoirs of the Metropolitan Water Works, the elevations of the water surface in feet above Boston City Base, and the quantity of water stored in each reservoir at the beginning and end of the year, are shown by the following table.

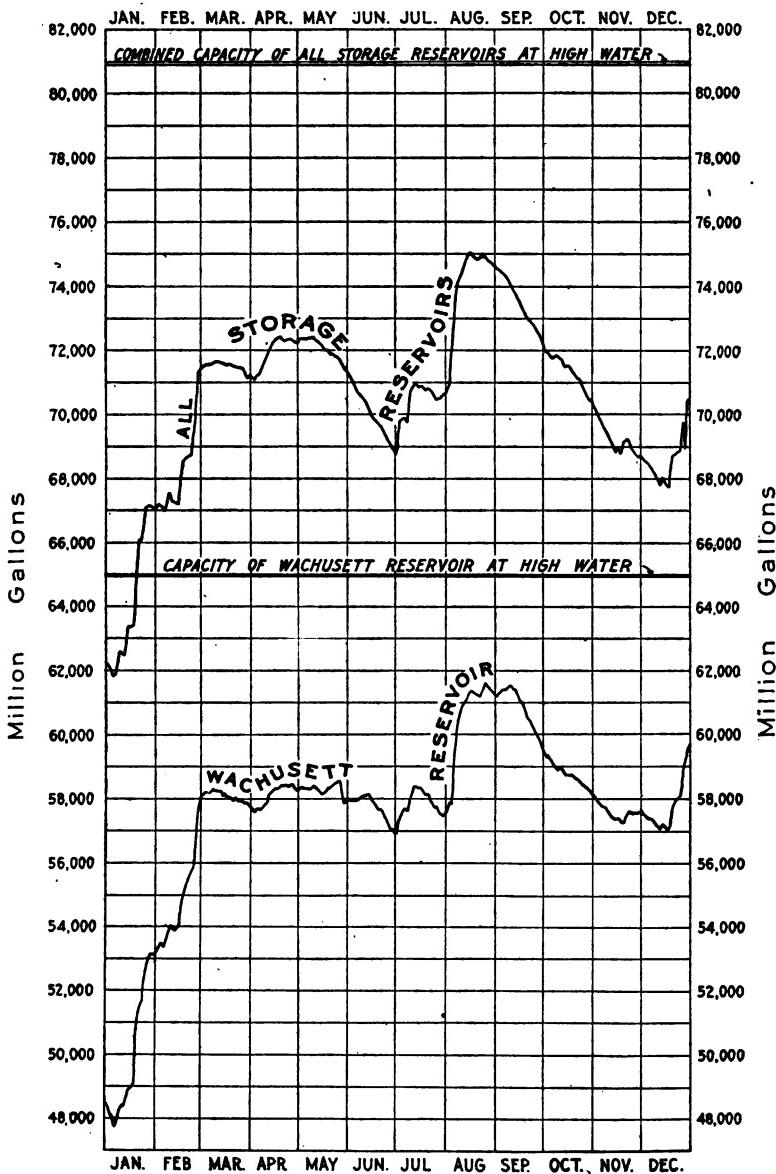
STORAGE RESERVOIRS.	Eleva- tion ¹ of High Water.	Capacity (Gallons).	JAN. 1, 1915.		JAN. 1, 1916.	
			Eleva- tion ¹ of Water Surface.	Amount stored (Gallons).	Eleva- tion ¹ of Water Surface.	Amount stored (Gallons).
Cochituate watershed:—						
Lake Cochituate, includ- ing Dudley Pond.	144.36	2,328,300,000	142.62	1,825,000,000	142.93	1,920,100,000
Sudbury watershed:—						
Sudbury Reservoir,	260.00	7,253,500,000	257.81	6,343,000,000	249.53	3,340,300,000
Framingham Reservoir No. 1.	169.75	287,500,000	167.66	214,400,000	167.89	224,300,000
Framingham Reservoir No. 2.	177.87	529,900,000	175.98	480,900,000	176.19	489,900,000
Framingham Reservoir No. 3.	186.74	1,180,000,000	183.03	902,900,000	184.48	1,017,600,000
Ashland Reservoir,	225.21	1,416,400,000	224.34	1,368,500,000	224.53	1,379,000,000
Hopkinton Reservoir,	305.00	1,520,900,000	304.05	1,461,500,000	304.24	1,473,300,000
Whitehall Reservoir,	337.91	1,256,900,000	337.66	1,208,000,000	337.29	1,136,200,000
Farm Pond,	159.25	167,500,000	158.66	136,000,000	157.87	94,400,000
Wachusett watershed:—						
Wachusett Reservoir,	395.00	64,968,000,000	381.89	48,438,100,000	391.05	59,728,600,000
Totals,	-	80,908,900,000	-	62,379,200,000	-	70,813,700,000

¹ Elevation in feet above Boston City Base.² To top of Flashboards.

The diagram, page 61, is submitted to show the quantity of water stored in the Wachusett Reservoir and the quantity stored in all the storage reservoirs combined at any time during the year.

Wachusett Reservoir.—The water in this reservoir was 13.11 feet below high-water mark at the beginning of the year. It fell 0.72 of a foot during the following week and the water surface was at elevation 381.17 on January 6, which was the lowest elevation reached during the year. From January 6 to March 1 the reservoir filled rapidly to elevation 389.81. On account of the small draft from the reservoir, due to drawing down Sudbury Reservoir in connection with the installation of the hydro-electric plant at the Sudbury Dam, and to the low rainfall, the elevation of the water surface remained between elevation 388.88 and 390.17 until August 4. On account of the heavy precipitation during August, the reservoir filled quite rapidly during the early part of the month and the water surface reached elevation 392.42 August 25, which was the maximum elevation reached during the year. From August 25 to December 18 the water in the reservoir was drawn down gradually at the rate of about 1 foot a month to elevation 388.98, and after December 18 the water

QUANTITY OF WATER STORED IN THE WACHUSSETT RESERVOIR
AND IN ALL THE STORAGE RESERVOIRS COMBINED
DURING 1915



rose about 2 feet and was at elevation 391.05 at the end of the year. No water was wasted from the reservoir during the year.

In compliance with the requirements of chapter 488 of the Acts of the year 1895, 1,049,500,000 gallons of water was discharged from the reservoir into the Nashua River through the pool below the dam and through the pipe line which discharges directly into the Lancaster Mills canal at a rate of not less than 12,000,000 gallons per week for the use of the mills.

No soil stripping has been necessary along the shores of the reservoir this year, but miscellaneous débris brought into the reservoir during the spring floods has been collected from the shores and disposed of.

Cunningham's Brook at the westerly end of the North Dike, and two small brooks tributary to Thomas Basin were improved for an aggregate length of 1,568 feet at a cost of \$711.97. The brush and weeds on a strip 50 feet in width along the margin of the reservoir on the face and riprap berm of the North and South dikes, along the sides of brooks flowing directly into the reservoir and along all highways adjoining the reservoir lands have been mowed, raked up and burned. This work extended for a distance of 56 miles and cost \$3,186.22.

Party fences between the Metropolitan Water Works lands and adjoining lands were constructed for a length of 1,013 feet, of chestnut posts and old telephone wire. An equal amount of similar fence was built by the owners of the adjoining lands.

The Wachusett Dam and adjacent structures and grounds have received the usual care and are in good condition. The road up the westerly hillside to the waste-weir was resurfaced for a length of 830 feet and a width of 12 feet where washed out by the excessive rains in August. As a safeguard for the employees, electric wiring has been arranged so that the electric lamps in the gate-chamber are lighted when the door is opened.

The barn at the Lamson place in Boylston, which was left standing when the house was sold in 1914, has been torn down and rebuilt at the Cook place, Lancaster Street, West Boylston, at a cost of \$1,374.09, including considerable grading around the barn and the construction of about 150 linear feet of wire fence along the highway. The Kramer house on Wilson Street, Clinton, was partially destroyed by a fire, due to a defective chimney, October 9, and was repaired at a cost of \$654.36.

Sudbury Reservoir. — The water in the Sudbury Reservoir was 1.19 feet below the crest of the wasteway at the beginning of the year and rose to elevation 259.20 on January 20. By February 23 it had fallen to elevation 256.93. It rose to elevation 258.12 about the middle of March and then fell gradually until the middle of May, when it was at elevation 257.00. During the following month the water was drawn down to elevation 252.00 to facilitate the work of preparing the gate-house for the power plant. About August 15 the reservoir had been filled to elevation 256.00 in connection with the operation of the Wachusett power plant. The water was again drawn down to about elevation 253.00 by the middle of September and remained at about this elevation until the latter part of October. During November and December the water was gradually drawn down to elevation 249.00, to provide for the installation of the new sluice gates for the power plant, and was at elevation 249.53 at the end of the year.

Advantage was taken of the low water in the Sudbury Reservoir to remove the sediment which had collected in the various inlet channels, and to repoint all joints in the top and up-stream face of the masonry wasteway above elevation 254.9, also in the water side of the substructure of the gate-house. The joints in the down-stream side of the circular dam above Middle Road and in the arch bridge at Parkerville Road were also repointed, and the paving that was loose and out of position on the slopes of the roads crossing the reservoir was relaid.

A growth of vegetation which occurred below high-water line, on account of the low water in the reservoir, was mowed and burned and the Southborough swimming pool was cleaned.

Additional stop-planks, equivalent to a total height of 50 feet, were made for use at the gate-house if required in connection with the installation of the power plant. The driving horse at the Sudbury Dam was sold, on account of injury received from a fall, and an automobile truck, made from a Ford runabout, was purchased. As a result the foreman has been able to give the work much more efficient supervision than formerly. The grounds about the Sudbury Dam have been given the usual attention.

Sprouts and brush were mowed in the lanes through the woods along the land boundaries for a total length of 8 miles. Wheelock No. 65 wire fence has been constructed for a distance of 638 feet between the reservoir land and adjoining lands.

Framingham Reservoir No. 3. — The water in this reservoir was maintained within a few feet of the top of the wasteway during the entire year and no water was wasted from the reservoir. The gate-house and grounds about the dam have been given the usual attention and are in good condition. The carriage shed and store-house near the dam was repaired and painted. Chestnut posts were set for a distance of 2,500 feet for fence between the reservoir land and land of Andrew O. Stensson on the northerly side and at the head of the reservoir, and, with the posts set last year, the entire line is now ready for the wire fence.

Framingham Reservoirs Nos. 1 and 2, Ashland, Hopkinton and Whitehall Reservoirs. — No water has been drawn from these reservoirs for supplying the Metropolitan Water District during the year. A waste of not less than 1,500,000 gallons of water per day has been maintained at Framingham Dam No. 1, as required by the provisions of chapter 177 of the Acts of the year 1872, and additional quantities of water have been wasted from time to time as required to dispose of the yield of the watersheds tributary to these reservoirs.

During the year the water in Framingham Reservoir No. 1 averaged about 1 foot above, in Framingham Reservoir No. 2 about 0.9 of a foot above, in Ashland Reservoir 0.5 of a foot above and in the Hopkinton Reservoir 0.4 of a foot above the crest of the wasteway. The average elevation of the water in Whitehall Reservoir was about 0.2 of a foot below high-water mark. The gate-houses and grounds about the dams at these reservoirs have been given the usual attention and are in satisfactory condition.

The small dam at the outlet of the small basin near the Neyhart land and Salem Street, at Framingham Reservoir No. 1, was repaired and a new box culvert constructed. The trees and brush have been cut and removed for a width of 5 feet along the boundaries of the Water Works lands for a distance of about 8 miles, and brush has been mowed along boundary lanes previously cut for a distance of about 22 miles. Vegetation has been mowed and burned along the outlet channels below Ashland and Hopkinton reservoirs.

Wheelock No. 65 wire fence was constructed for a distance of 1,490 feet along the boundary of the Water Works land below the dam at Ashland Reservoir and the gate-keeper's house was painted.

At the Hopkinton Reservoir the grass and weeds on the filter-beds were mowed and burned and the gate-keeper's house was painted.

New stop-planks were made and put in position on the up-stream

side of the gates in the outlet flume at Whitehall Reservoir and a portion of the up-stream masonry facing of the upper mill pond dam, which had been pushed out of position by the freezing of the earth behind it, was rebuilt. The brush and weeds in the lower mill pond site were cut and burned and the brook channel between Wood Street and the lower dam was cleaned out and straightened. This work has greatly improved the appearance of our land. Four cottages were built at Whitehall Reservoir during the year. There are now 65 cottages located on the shores of the reservoir, and 10 motor boats, 83 row boats and 30 canoes were in use during the year, which is an increase of 10 over the number in use in 1914.

Farm Pond. — No water was discharged into or wasted from Farm Pond during the year, and the average elevation of the water in the pond was about 1 foot below high-water mark. The town of Framingham pumped 228,600,000 gallons of water from the filter-gallery on the shore of the pond during the year for a portion of its water supply, and the balance of 57,400,000 gallons was pumped from the Sudbury Aqueduct. For several years the sprouts and brush that have grown up between the paving stones on the sides of the Farm Pond dike and Farm Pond aqueduct have been mowed, and the roots had increased in size until they had pushed the paving out of position in places. This year the paving was taken up and the roots were removed and the paving then replaced in proper position.

Lake Cochituate. — No water was discharged from the lake into the Cochituate Aqueduct and no water was received from the Sudbury watershed or Dudley Pond during the year. The elevation of the water in the reservoir averaged about 1 foot below high-water mark and water was wasted at the outlet dam during each month except April, May and June. A new entrance was built at the carriage house at the foreman's residence so that automobiles and auto-trucks can be run into the house to be overhauled and repaired. The tin roof of the effluent gate-house was blown off December 26 by a heavy wind storm, and arrangements for repairing the roof were being made at the close of the year. Material which had accumulated in the sand catcher and catch basins of the surface water drain from Cochituate Village has been removed as required. The slopes of the open channel have been mowed and the channel has been kept in proper condition to discharge the surface water. The buildings and grounds in the vicinity of the effluent gate-house and of the foreman's residence have been given proper care, and leaves

and débris have been removed from the shores of the lake. An iron pipe fence has been erected on the water side of the screen-cleaning platform in the effluent gate-house to safeguard the employees. Twelve cottages and 3 garages were built on the shores of the lake and 1 cottage was torn down, leaving a total of 74 cottages at the end of the year.

Dudley Pond. — No water has been discharged into Lake Cochituate from this pond during the past ten years. During the year 10 cottages and 1 boat-house were built in the immediate vicinity of the pond, making a total of 46 cottages, 2 ice-houses and 3 boat-houses along the shores at the end of the year. Between these buildings and the Cochituate-Wayland Road and on the north side of the pond 14 cottages were built during the year, making a total of 80 cottages and 2 stores located within a short distance of the pond in addition to the buildings located along the shores of the pond. The pond is no longer of value for water supply purposes and under these conditions the expenditure necessary to maintain proper sanitary inspection does not appear to be warranted.

AQUEDUCTS.

Wachusett Aqueduct. — Water was discharged through this aqueduct from the Wachusett Reservoir during 260 days in 1915. The total time that the aqueduct was in use is equivalent to 123 days, 18 hours and 57 minutes, and the total quantity of water supplied was 25,652,400,000 gallons, equivalent to an average of 70,280,548 gallons per day for the entire year. The Westborough State Hospital pumped 68,602,000 gallons of water, equivalent to an average consumption of 188,000 gallons per day, from the open channel at the lower end of the aqueduct. The usual care has been given to the aqueduct lands and structures and 12,950 feet of Wheelock No. 65 wire fence has been erected along the boundary of the aqueduct lands, and 364 feet of stone wall was rebuilt. The cost of this work was \$1,879.60.

During September the interior surface of the aqueduct on the Assabet Bridge was given two coats of Portland cement grout containing about 2 per cent. of Medusa waterproofing compound, to determine its effect upon the leakage from the aqueduct at this place, which appears to take place through fine cracks in the brick lining. Before applying the cement grout the surface of the masonry was thoroughly cleaned with wire brooms and a strong solution of car-

bonate of soda. The section of the aqueduct treated is 353 feet in length and about 1,100 square yards of surface were covered at a cost of \$240.99. While it is evident that a large portion of the leakage has been stopped, opportunity has not been had to make observations during freezing weather after the aqueduct has been flowing full for a few days.

Water grass and weeds were removed from the bottom of the open channel between the lower and upper dams for a distance of 2.06 miles, the bunch grass and other vegetation were removed from the shore lines, and the slopes at the flow line were regraded with material which had been washed down the slope and were then faced with heavy gravel found along the shore. The cost of the work was \$1,020.88 or 4.7 cents per linear foot of shore line, which is equivalent to a cost of 0.3 of a cent per linear foot of shore line per year since the channel was put into service. The granite masonry at the lower dam and at five highway bridges over the channel was repointed where necessary and the iron rail fences were painted. On the north side of the channel, just below the upper dam, a very unsightly area of about 4 acres, in plain view from the railroad and highway, has been improved by constructing 167 linear feet of board-bottom drainage ditch and grading and seeding the land, so that it is now an attractive field and the quality of the water draining into the open channel at this place has been materially improved.

Sudbury Aqueduct. — This aqueduct was in constant use for delivering water from Framingham Reservoir No. 3 to the Chestnut Hill Reservoir every day during the year. The average daily flow in the aqueduct was 63,261,000 gallons. The usual care has been given to the aqueduct lands and structures. The openings around the screens in the gate-house at Farm Pond were covered with planks to safeguard the employees. Trees and brush were cut for a width of 5 feet along the boundary of the aqueduct land in the swamp on both sides of South Main Street in Natick. Quite a number of large old elm and willow trees were cut down near Brook Street, South Natick, as the roots of the trees had begun to grow through the aqueduct. A 24-inch cast-iron pipe sewer was laid by the town of Wellesley across the aqueduct land under the Waban Valley bridge through the third arch from the east end. An unsightly slope at the cut on the north side of Duncklee Street in Newton Highlands was graded and improved.

Weston Aqueduct. — During 349 days in 1915 water was supplied from the Sudbury Reservoir through this aqueduct. The total time

that the aqueduct was in use is equivalent to 345 days, 17 hours and 30 minutes, and the total quantity of water delivered into the Weston Reservoir was 12,254,100,000 gallons, equivalent to an average flow of 33,573,000 gallons per day for the entire year. Between November 8 and 20 the interior of the aqueduct was cleaned from the head-chamber, near the Sudbury Dam in Southborough, to the manhole near the west portal of tunnel No. 4, located about 2,000 feet west of Highland Street in Weston, a distance of about 10 miles, and from the Weston Reservoir to the terminal chamber in Weston, a distance of about 1 mile. At the upper end, from the head chamber to Nobscot, there was very little deposit on the masonry, but at the lower end where the velocity of the water is less than in the upper portion of the aqueduct, the deposit on the masonry was as much as $\frac{1}{8}$ of an inch in thickness and adhered firmly to the walls. The cost of the work was \$674.25. From the manhole at the west portal of tunnel No. 4 to the Weston Reservoir, a distance of about 1 $\frac{1}{4}$ miles, the aqueduct cannot be drained except by pumping out the water and this section was not cleaned. The aqueduct lands and structures have been given the usual attention.

The house and barn at the White place in Nobscot have been repaired, and lanes 5 feet in width were cut through the woods along the boundary lines of the aqueduct at this place. Fences along the boundaries of the aqueduct land have been repaired for an aggregate length of 4,675 feet. The iron hooks supporting the balance weights attached to ladders in the aqueduct manholes were replaced with brass hooks as the old hooks had become weakened by rust.

Cochituate Aqueduct. — This aqueduct was not used during the year. The aqueduct lands and structures have been given the usual attention. The channel from the culvert under Dedman's waste-weir to Morse's Pond was straightened and improved. The grading and surfacing of the unsightly slope of the deep cut on the easterly side of Beacon Street in Newton, which was begun last year, has been completed and the appearance of the land has been very much improved by this work.

PUMPING STATIONS.

At the two stations at Chestnut Hill Reservoir 12,922,060,000 gallons of water was pumped into the low-service mains of which 2,724,660,000 gallons was repumped at the Spot Pond and Arlington stations for the northern high and extra high services, and

11,808,610,000 gallons was pumped into the southern high-service mains, of which 250,970,000 gallons was repumped for the southern extra high service. The total amount of water pumped at all the pumping stations was 27,706,300,000 gallons, which is 1,024,860,000 gallons less than in 1914, and the total cost of operating all the stations was \$96,847.21, which is \$7,958.99 less than in 1914, the saving being due largely to the smaller amount expended for repairs. The cost per million gallons is \$3.495 in 1915 as compared with \$3.648 in 1914.

The amount of coal furnished by various parties at the pumping stations and the cost of the coal is as follows:—

DEALERS.	STATIONS (AMOUNT IN GROSS TONS).					Cost per Gross Ton in Bins. ¹
	Chestnut Hill No. 1.	Chestnut Hill No. 2.	Spot Pond.	Arlington.	Hyde Park.	
Gorman-Leonard Coal Co., bituminous,	793.88	—	—	—	—	\$4.14
Gorman-Leonard Coal Co., bituminous,	—	1,145.56	—	—	—	3.93
H. N. Hartwell & Son, Inc., bituminous,	—	2,577.01	—	—	—	4.08
C. W. Clafin & Co., anthracite-buckwheat,	153.35	—	—	—	—	3.08
C. W. Clafin & Co., anthracite-buckwheat,	—	979.06	—	—	—	2.92
Bader Coal Co., bituminous,	—	—	774.21	—	—	5.06
Looke Coal Co., anthracite-screenings,	—	—	233.03	—	—	2.50
Bader Coal Co., bituminous,	—	—	—	167.62	—	4.36
Hetherington & Co., bituminous,	—	—	—	253.30	—	4.32
Gorman-Leonard Coal Co., bituminous,	—	—	—	—	96.43	4.11
Quemahoning Coal Co., bituminous,	—	—	—	—	137.72	4.19
Total, bituminous,	793.88	3,722.57	774.21	420.92	234.15	—
Total, anthracite-buckwheat,	153.35	979.06	—	—	—	—
Total, anthracite-screenings,	—	—	233.03	—	—	—
Average cost, bituminous:—						
In bins,	\$4.14	\$4.03	\$5.06	\$4.33	\$4.16	—
On cars,	3.89	3.96	—	4.25	4.00	—
Average cost, anthracite-buckwheat:—						
In bins,	3.08	2.92	—	—	—	—
On cars,	2.86	2.83	—	—	—	—
Average cost, anthracite-screenings, in bins,	—	—	2.50	—	—	—

¹ Includes cost of unloading coal from cars and all expenses incidental to storage of the coal.

All bituminous coal was purchased under specifications which provide for a variation in price with variation in heat units and ash as determined by analysis. The price per ton was reduced 2 cents for each 50 heat units or fraction thereof less than 14,700 per pound of dry coal, and 1 cent for each $\frac{1}{2}$ of 1 per cent. or fraction thereof of ash in the dry coal in excess of 8 per cent. For each 50 heat units or fraction thereof in excess of 14,800 per pound of dry coal the price per ton was increased 1 cent. The results of analyses of the bituminous coal purchased during 1915 are as follows:—

KIND OF COAL.	Number of Samples tested.	British Thermal Units.	Percent-age of Volatile Matter.	Percent-age of Ash.	Percent-age of Moisture.	Percent-age of Fixed Carbon.
Alpha Special, . . .	31	14,817	21.23	6.37	2.61	72.40
Beaver Run, . . .	25	14,477	16.68	8.63	3.13	74.69
New River, . . .	13	14,840	17.10	6.11	3.14	76.79
Brasil Smokeless, . . .	6	14,628	20.44	7.66	1.99	71.90
Davenport, . . .	6	14,872	18.31	6.03	2.45	75.66
Ralston, . . .	4	14,608	16.56	7.54	2.62	75.90
Carbon Forge, . . .	4	14,402	17.15	9.08	2.28	73.77

Chestnut Hill Pumping Stations.

The quantity of water pumped at these stations into the southern high-service mains averaged 32,352,000 gallons per day during 1915, or 1,338,000 gallons per day less than in 1914. The cost per million gallons pumped was 45.67 cents less than in 1914.

The southern high-service pumping statistics for 1915 are as follows:—

	PUMPING STATION No. 1.		PUMPING STATION No. 2.	Totals.
	Engine No. 1.	Engine No. 4.	Engine No. 12.	
Daily pumping capacity (gallons),	8,000,000	30,000,000	40,000,000	78,000,000
Total quantity pumped (million gallons),	289.20	2,898.98	8,620.42	11,808.61
Daily average quantity pumped (gallons),	792,000	7,942,000	23,618,000	32,352,000
Coal used (pounds),	904,430	1,893,530	5,788,640	8,586,600
Gallons pumped per pound of coal,	319.76	1,531.00	1,489.20	1,375.24
Average lift (feet),	133.80	119.38	123.26	122.56
Cost of pumping:—				
Labor,	\$2,710.62	\$7,254.88	\$8,660.37	\$18,625.87
Fuel,	1,692.97	3,404.69	10,433.98	15,531.64
Repairs,	360.40	1,045.33	695.30	2,101.03
Oil, waste and packing,	35.14	94.05	238.51	367.70
Small supplies,	44.73	119.71	83.88	248.32
Totals,	\$4,843.86	\$11,918.66	\$20,112.04	\$36,874.56
Cost per million gallons pumped,	\$16.7492	\$4.1113	\$2.3331	\$3.1227
Cost per million foot gallons, . . . . .	.1252	.0344	.0189	.0255

The quantity pumped into the low-service mains averaged 35,403,000 gallons per day during 1915, or 837,000 gallons per day less than in 1914. The cost per million gallons pumped was 6.74 cents more than in 1914.

The low-service pumping statistics for 1915 are as follows:—

	Chestnut Hill Pumping Station No. 2.—Engines Nos. 5, 6 and 7.
Daily pumping capacity each engine (gallons),	35,000,000
Total quantity pumped (gallons),	12,922,060,000
Daily average quantity pumped (gallons),	35,403,000
Total coal used (pounds),	4,527,085
Gallons pumped per pound of coal,	2,854.39
Average lift (feet),	40.34
Cost of pumping:—	
Labor,	\$19,149 51
Fuel,	8,196 34
Repairs,	2,328 01
Oil, waste and packing,	388 01
Small supplies,	152 39
Total,	\$30,164 26
Cost per million gallons pumped,	\$2.3343
Cost per million foot gallons, . . . . .	.0579

During September the track scale used for weighing coal received at the Chestnut Hill stations was overhauled and put in accurate adjustment with the Fairbanks Company's 80,000-pound test car. All scales used for weighing the coal as fed to the boilers were tested and put in accurate adjustment.

Spot Pond Pumping Station.

At this station water is pumped for the northern high-service district. The quantity pumped averaged 6,778,000 gallons per day during 1915, or 589,000 gallons per day less than in 1914. The cost per million gallons pumped was 14.62 cents more than in 1914, although the total cost of pumping was \$868.51 less than in 1914.

The northern high-service pumping statistics for 1915 are as follows:—

Total quantity pumped (gallons),	2,473,990,000
Daily average quantity pumped (gallons),	6,778,000
Total coal used (pounds),	2,209,787

Gallons pumped per pound of coal,	1,119.56
Average lift (feet),	127.87
Engine No. 8 operated (hours),	43
Engine No. 9 operated (hours),	2,957
Quantity pumped by Engine No. 8 (gallons),	18,460,000
Quantity pumped by Engine No. 9 (gallons),	2,455,530,000
Cost of pumping:—	
Labor,	\$9,389.84
Fuel,	4,543.26
Repairs,	234.64
Oil, waste and packing,	183.15
Small supplies,	174.71
Total for station,	\$14,525.60
Cost per million gallons pumped,	\$5.8713
Cost per million foot gallons, . . . . .	.0459

Arlington Pumping Station.

At this station water is pumped for the northern extra high-service district. The quantity pumped averaged 687,000 gallons per day during 1915, or 31,000 gallons per day less than in 1914. The cost per million gallons pumped was \$2.51 more than in 1914, the total increase in cost of operating the station in 1915 being \$275.40.

The northern extra high-service pumping statistics for 1915 are as follows:—

Total quantity pumped (gallons),	250,670,000
Daily average quantity pumped (gallons),	687,000
Total coal used (pounds),	1,024,020
Gallons pumped per pound of coal,	244.79
Average lift (feet),	281.43
Engine No. 10 operated (hours),	5,712
Engine No. 11 operated (hours),	284
Quantity pumped by Engine No. 10 (gallons),	241,540,000
Quantity pumped by Engine No. 11 (gallons),	9,130,000

Cost of pumping:—	
Labor,	\$6,021.70
Fuel,	1,964.63
Repairs,	287.45
Oil, waste and packing,	62.55
Small supplies,	98.65
Total for station,	\$8,434.98
Cost per million gallons pumped,	\$33.6497
Cost per million foot gallons, . . . . .	.1196

Hyde Park Pumping Station.

At this station water is pumped for the southern extra high-service district. The quantity pumped averaged 688,000 gallons per day during 1915, or 12,000 gallons per day less than in 1914. The cost per million gallons pumped was \$1.08 less than in 1914, the total cost of pumping in 1915 being \$403.53 less than in 1914. The saving was due largely to smaller expenditures for repairs and supplies.

Water was pumped from this station to the new Bellevue Reservoir between January 7 and 15, January 22 and March 25 and July 1 and September 30, a total of 162 days. The old reservoir was also in use during these periods and during the remainder of the year.

The southern extra high-service pumping statistics for 1915 are as follows:—

Total quantity pumped (gallons),	red.	250,970,000
Daily average quantity pumped (gallons),		688,000
Total coal used (pounds),		504,706
Gallons pumped per pound of coal,		497.26
Average lift (feet),		122.83
Engine No. 13 operated (hours),		1,169
Engine No. 14 operated (hours),		4,100
Quantity pumped by Engine No. 13 (gallons),		44,240,000
Quantity pumped by Engine No. 14 (gallons),		206,730,000

Cost of pumping:—

Labor,	\$5,577 65
Fuel,	965 75
Repairs,	99 41
Oil, waste and packing,	71 85
Small supplies,	133 15
 Total for station,	 \$6,847 81
 Cost per million gallons pumped,	 \$27.2854
Cost per million foot gallons, . . . . .	.2221

Additional information regarding the operation of the pumping engines at these pumping stations is given on pages 164 to 172.

CONSUMPTION OF WATER.

The average consumption of water in the 18 municipalities supplied from the Metropolitan Water Works during the year, as measured by the Metropolitan Water Works meters, was 101,941,500 gallons per day, which, on the basis of an estimated population of 1,164,600, is equivalent to 88 gallons per capita per day. The total consumption in each of the municipalities in 1915 was less than in 1914, with the exceptions of the city of Malden and the town of Watertown, and the per capita consumption was less in 1915 than in 1914 in all of the municipalities, with the exception that there was no change in the per capita consumption in Malden and Watertown. The consumption in the municipalities supplied was 5,094,600 gallons per day less in 1915 than in 1914, or 4.76 per cent. less than the 1914 consumption. This was probably due in large measure to climatic conditions, as there was no long period of extremely cold weather or of extremely hot dry weather during 1915, which would cause the consumption to be larger than usual.

The diagram on page 76, showing population and consumption of water in the Metropolitan Water District since 1890, indicates that the reduction in the per capita use of water in 1915, due to the installation of meters, resulted in saving more water than was required to supply the annual increase in the population, for the total consumption of the District has continued to diminish to a noticeable extent.

The average rates of consumption of water in the various municipalities in 1915 during the entire day and during the three hours between 1 and 4 at night are shown on the diagram opposite page 76. The average daily consumption of water in each of the municipalities supplied from the Metropolitan Water Works during 1914 and 1915, as measured by the Metropolitan Water Works meters, is as follows:—

	Estimated Popula- tion, 1915.	AVERAGE DAILY CONSUMPTION.				Decrease in Gallons.	
		1914.		1915.			
		Gallons.	Gallons per Capita. ¹	Gallons.	Gallons per Capita.		
Boston,	748,890	81,877,800	111	77,851,800	104	4,226,000	
Somerville,	87,320	6,199,800	73	5,807,100	67	392,700	
Malden,	49,160	2,237,900	46	2,243,000	46	5,100 ²	
Chelsea,	43,750	2,904,400	70	2,901,400	66	3,000	
Everett,	37,950	2,688,100	72	2,599,100	68	89,000	
Quincy,	40,940	2,609,200	66	2,511,800	61	97,400	
Medford,	36,820	1,258,900	43	1,245,200	40	13,700	
Melrose,	16,960	932,500	56	851,500	50	81,000	
Revere,	25,500	1,551,000	64	1,484,800	58	66,200	
Watertown,	16,660	984,800	62	1,025,200	62	40,400 ²	
Arlington,	15,050	860,500	60	825,300	55	35,200	
Milton,	8,650	346,700	41	338,900	39	7,800	
Winthrop,	12,900	722,800	58	700,300	54	22,500	
Stoneham,	7,510	378,800	51	373,700	50	5,100	
Belmont,	8,180	497,500	65	425,400	52	72,100	
Lexington,	5,570	373,800	69	358,700	64	15,100	
Nahant,	1,400	171,600	126	161,900	116	9,700	
Swampscott,	7,390	440,000	61	436,400	59	3,600	
District,	1,164,800	107,036,100	94	101,941,500	88	5,094,600	

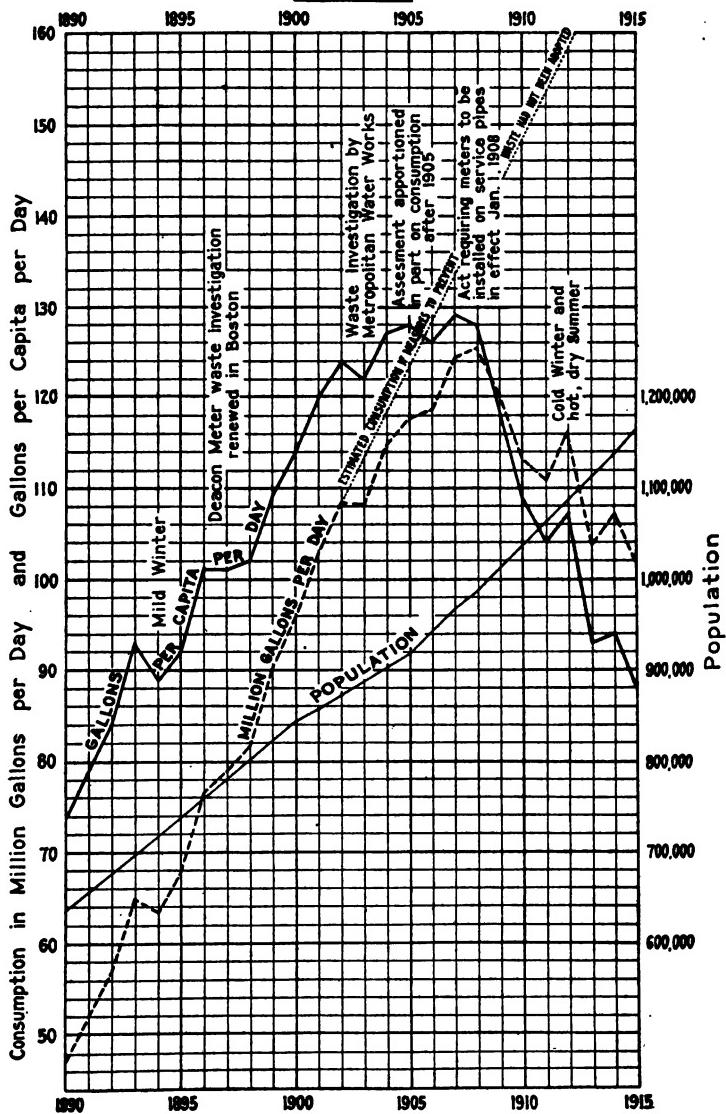
¹ The populations for 1914 were revised after the census of 1915 became available, and consequently these per capita figures differ from the figures published in the 1914 report.

² Increase.

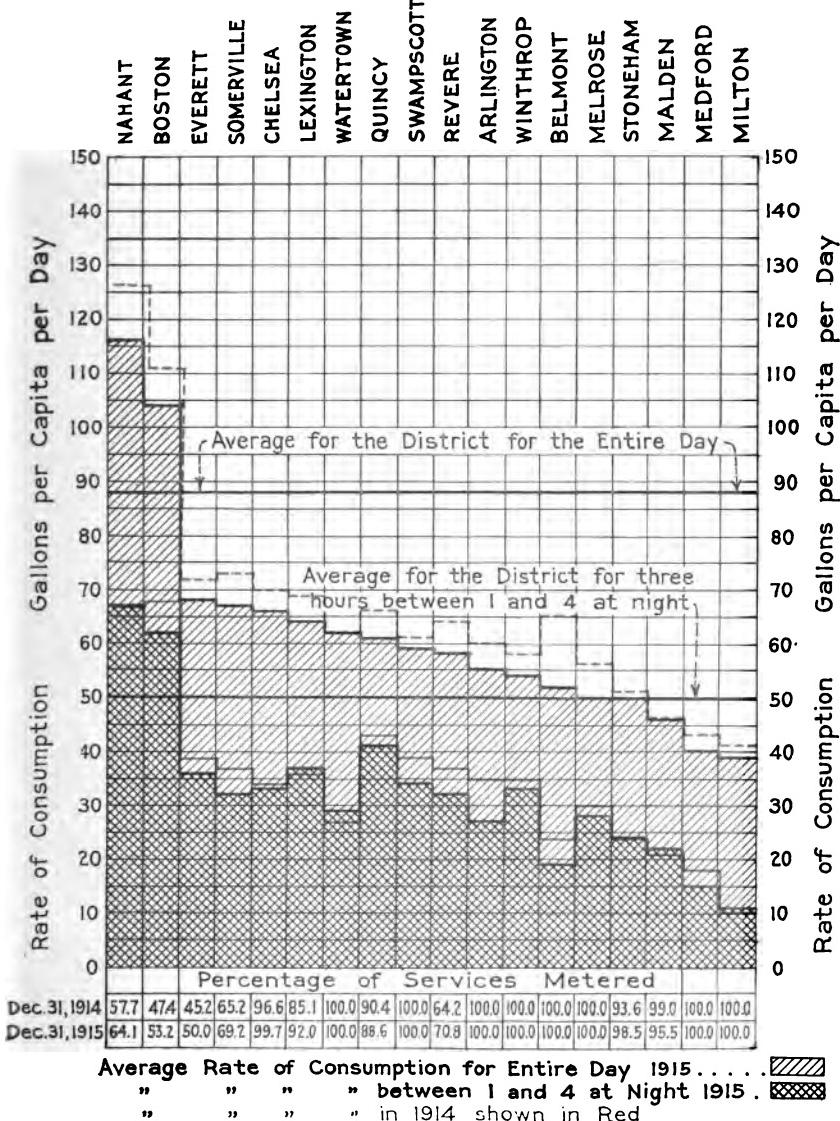
The average consumption in the several districts was as follows:—

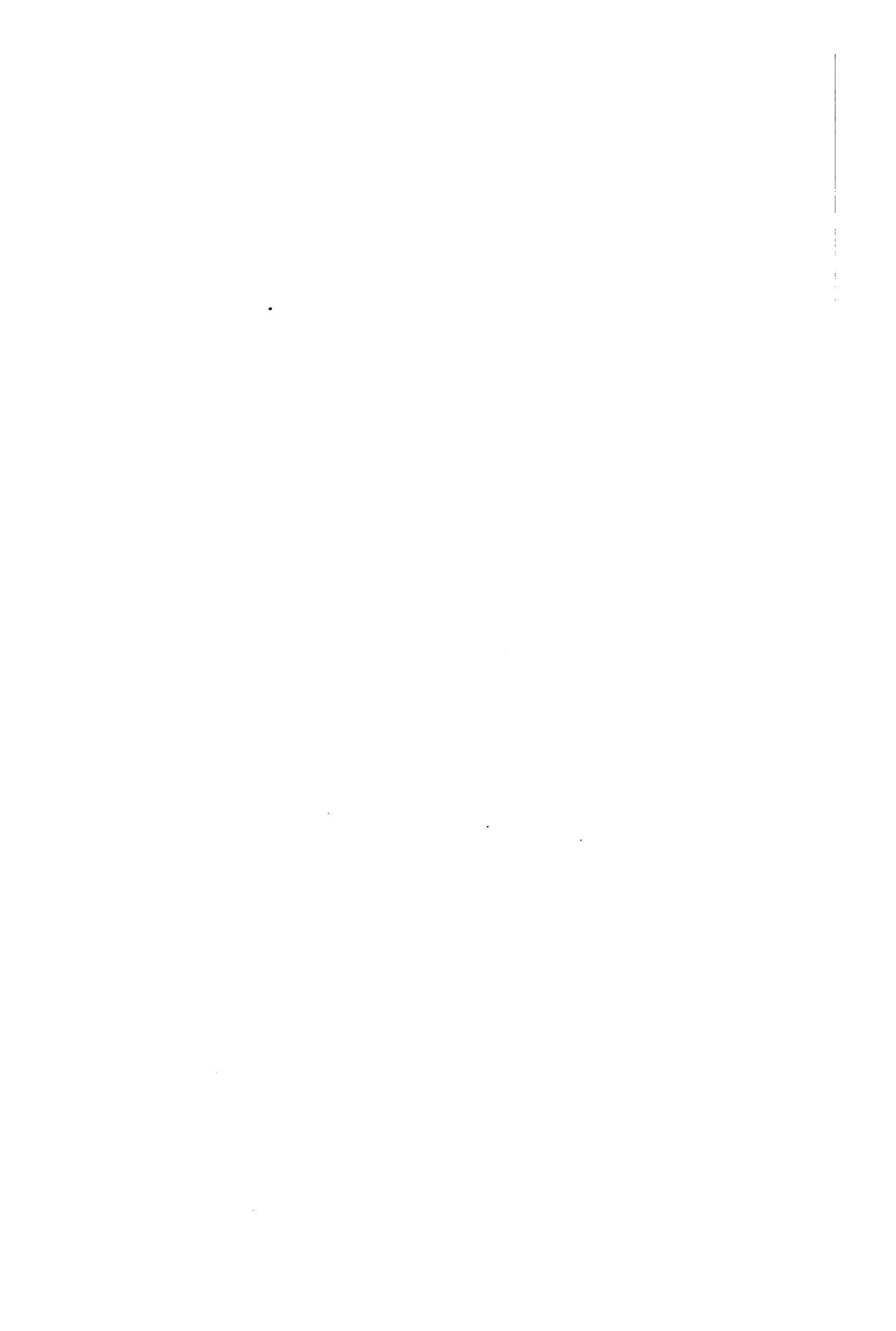
		Gallons per Day, 1915.	DECREASE FROM 1914.	
			Gallons per Day.	Percent- age.
Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston,		41,976,400	3,376,700	7.45
Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston,		19,428,700	1,063,800	5.19
Southern high-service district, embracing Quincy and Watertown, the high-service districts of Boston, and portions of Belmont and Milton,		31,775,400	409,800	1.27
Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston,		7,398,200	138,000	1.83
Southern extra high-service district, embracing the higher portions of Hyde Park, Milton and West Roxbury,		668,000	77,400	10.38
Northern extra high-service district, embracing Lexington and the higher portions of Arlington and Belmont,		694,800	28,900	3.99
Totals,		101,941,500	5,094,600	4.76

POPULATION AND CONSUMPTION OF WATER
— IN THE —
METROPOLITAN WATER DISTRICT
AS SUPPLIED IN 1915
FROM 1890 TO 1915



**AVERAGE RATE OF CONSUMPTION OF WATER
IN THE METROPOLITAN WATER DISTRICT IN 1915
FOR THE ENTIRE DAY
AND
FOR THREE HOURS BETWEEN 1 AND 4 AT NIGHT**





CITY OR TOWN.	METERS ON OLD SERVICES.												NEW SERVICES.											
	1908.			1910.			1911.			1912.			1913.			1914.			1915.			TOTALS.		
	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.	METERS ON OLD SERVICES Number of Meters Equipped to Date of Year.				
Boston,*	84	5,503	5,481	6,487	6,023	5,600	6,897	5,418	40,492	459	4,281	4,223	3,288	1,513	12,351	1,380	13,731	9,454	1,411	10,845	54,848	63,15		
Somerville,	411	722	621	501	570	488	508	423	2	3	-	120	112	944	127	1,071	210	1,723	1,497	295	1,702	13,223	13,15	
Malden,	14	43	62	8	2	-	-	-	-	132	3	3	2,959	1,920	1,920	166	920	737	166	920	8,045	9,924	9,54	
Chelsea,	240	186	756	779	1,092	132	33	6	3	215	261	235	2,061	2,016	685	128	833	707	128	4,97	5,867	5,772		
Everett,	252	338	125	277	215	215	215	215	215	647	193	21	4,446	1,840	2,839	408	3,247	2,149	176	2,325	5,836	5,01		
Quincy,	230	338	33	423	1,630	1,090	1,090	1,090	1,090	847	178	6	7	4	3,534	1,432	4,12	3,870	1,420	406	1,826	5,846	100,00	
Medford,	179	887	927	1,555	1,555	1,555	1,555	1,555	1,555	7	5	-	12	2,591	932	532	90	715	93	806	6,043	4,005	4,211	
Melrose,	119	2,452	135	7	5	-	-	-	-	154	157	157	218	1,571	1,104	1,403	223	624	1,184	215	1,380	4,413	3,125	
Roxbury,	138	35	184	110	176	176	176	176	176	127	127	127	-	-	-	-	692	917	986	141	856	2,798	100,00	
Watertown,	-	-	-	-	-	-	-	-	-	261	349	-	-	-	964	440	738	249	867	769	247	1,016	2,753	
Arlington,	65	108	56	63	63	63	63	63	63	-	-	-	-	-	-	514	110	624	614	110	694	1,943	1,926	
Milton,	-	-	-	-	-	-	-	-	-	706	6	-	-	-	-	840	726	84	769	78	847	2,839	100,00	
Winthrop,	100	213	975	975	706	6	-	-	-	186	165	165	189	100	78	1,301	520	237	35	272	243	32	274	1,613
Stoneham,	65	116	225	186	186	186	186	186	186	-	-	-	-	-	-	618	100	715	615	100	715	1,430	1,420	
Belmont,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	419	45	464	383	51	453	1,156	1,156
Lexington,	32	113	70	56	86	95	95	95	95	17	4	4	48	67	53	268	128	168	77	245	173	37	530	91,96
Natick,	16	30	40	26	18	26	18	18	18	13	13	-	15	15	15	-	447	66	66	473	66	650	1,810	446
Swampscott,	21	264	142	28	28	28	28	28	28	-	-	-	-	-	-	-	-	-	-	-	-	-	100,00	
Totals,	6,148	5,971	9,984	10,206	10,880	8,723	7,735	7,444	6,538	48,980	67,480	48,980	27,083	4,143	31,226	23,268	3,345	27,103	176,183	117,526	66,31			

* The number of new meters installed and the number of new services equipped with meters seldom agree for the reason that service pipes are installed but meters are not set until the buildings are permanently occupied.

Installation of Meters on Service Pipes.

The results accomplished in the municipalities supplied with water from the Metropolitan Works, under chapter 524 of the Acts of the year 1907, which requires that each year meters shall be set on all new service pipes and on 5 per cent. of all service pipes that were without meters on December 31, 1907, are shown by the table on page 77.

The number of meters set on old services to December 31, 1915, by all of the municipalities is in excess of the number required to be set at this date by the statute, although the number set each year has not always been in accordance therewith. Making allowance for the fact that new services are not always put into use when installed, the number of new meters set on new services appears to be in accordance with the requirements of the statute with the exception that the cities of Boston, Malden, Quincy and Revere and the town of Watertown have not fully complied with the law.

In 12 of the municipalities practically all of the service pipes have now been equipped with meters. There has been an increase of 9,821 in the number of meters in use on service pipes in the municipalities supplied from the Metropolitan Water Works during the year, and 66.81 per cent. of all the service pipes had been provided with meters at the close of the year.

WATER SUPPLIED OUTSIDE OF METROPOLITAN WATER DISTRICT.

During the year 406,774,000 gallons of water were supplied from the Metropolitan Water Works for use outside of the Metropolitan Water District as follows:—

PLACES SUPPLIED.	Total Quantity (Gallons).	Average Quantity (Gallons per Day). ¹	Number of Days on which Water was supplied.	Amounts charged for Water supplied.
City of Worcester,	46,800,000	128,219	21	\$1,357 20
Westborough State Hospital,	68,602,000	188,000	365	2,058 06
Town of Framingham:—				
From Sudbury Aqueduct,	57,400,000	157,260	306	} 1,816 01
From Filter-gallery at Farm Pond,	228,600,000	626,301	365	
United States Government:—				
Peddock's Island,	28,152,000	77,100	365	1,770 46
Town of Saugus,	5,372,000	14,700	365	300 00

¹ For the entire year.

QUALITY OF THE WATER.

The quality of the water supplied during 1915 has been substantially the same as during the past few years. The yearly average results of the chemical analyses made by the State Department of Health and of the biological and bacteriological examinations made by this department of water from service taps in Boston since 1898 are given in tables on pages 185 to 188.

SANITARY CONDITIONS ON WATERSHEDS.

The inspection of the watersheds for the purpose of preventing the pollution of the water has been continued as in former years. In connection with this work the information for the sanitary census, which is taken every five years, has been obtained and the statistics for 1915, together with a summary of the statistics of the previous census in 1910, for comparison, are given in the following tables. Tables containing a summary of the work of sanitary inspection during the year are also given.

METROPOLITAN WATER

[Pub. Doc.]

Wachusett Watershed — Sanitary Census by District for 1915 and for entire Watershed for 1910 and 1915.

DISTRICT.	Parishes.	Population.	Domestic Animals.			
			Horses.	Cattle.	Sheep.	Poultry.
French Brook,	80	8	68	8	57	3
Muddy Brook,	33	2	2	3	40	-
Gates Brook,	167	8	15	8	187	8
Malden Brook,	25	5	1	2	33	-
Chaffin Brook,	186	2	7	11	206	87
Annebunkit Brook,	178	3	25	17	223	190
Muchopauge,	72	7	6	92	8	79
South Wachusett Brook,	61	10	8	8	87	-
Trout Brook,	20	-	3	3	35	-
East Wachusett Brook,	130	37	17	22	215	-
Sillwater River,	116	6	14	8	144	-
Waumecum,	140	161	16	14	331	-
French Hill,	32	-	1	1	34	-
Totals for 1915,	1,228	249	121	108	1,706	296
Totals for 1910, ¹	1,167	236	120	119	1,701	233

¹ Includes an area of 9.36 square miles of the Annebunkit Brook watershed which was diverted in 1913.

Sudbury and Cochituate Watersheds — Sanitary Census by Districts for 1915 and for Each Watershed for 1910 and 1915.

DISTRICT.	Parishes.	Population.				Domestic Animals.			
		Total.	Per Square Mile.	Horses.	Cattle.	Sheep.	Poultry.	Dogs.	
SUDSBURY WATERSHED.									
Farm Pond,	40	8	320	97	—	—	7	54	1,651
Franklin Reservoir No. 3,	272	—	268	30	10	—	7	54	1,651
Stony Brook,	84	3	268	30	10	—	—	54	1,651
Angle Brook,	1,362	6	116	39	20	1,618	—	284	1,651
Franklin Reservoirs Nos. 1 and 2, and Cold Spring Brook,	304	4	7	17	333	—	163	161	11,723
Eastern Sudbury,	193	3	22	8	226	—	177	235	1,366
Indian Brook,	345	4	21	35	405	—	265	398	1,366
Western Sudbury,	159	3	13	9	194	—	165	9	1,366
Whitehall Reservoir,	89	6	6	22	177	—	44	7,91	1,366
Cedar Swamp,	708	—	82	34	704	545	687	90	13
Totals for 1915,	4,274	87	299	189	4,849	2,466	3,601	1,090	69
Totals for 1910,	4,156	—	293	220	4,669	2,386	2,988	1,401	280
COCHITUATE WATERSHED.									
Snake Brook,	186	123	4	27	345	—	221	92	5
Pean Brook,	951	10	88	28	1,077	766	1,028	8	13
Course Brook,	115	—	3	12	130	2	66	51	1
Beaver Dam Brook,	1,476	30	90	58	1,654	1,268	1,414	166	16
Totals for 1915,	2,728	168	186	125	3,206	2,086	2,729	317	35
Totals for 1910, ¹	2,341	—	188	48	2,537	1,524	2,370	192	86
Area (Square Miles) including Water (Square Miles),									
Number on which there are Structures or Buildings but no Dwellings.									
Number on which there are Dwellings but no Buildings.									
Number of Dwellings throughout the Year.									
Number of Dwellings occupied throughout the Year.									
Number of Dwellings throughout the Year.									
Vacant.									
Connected with Sewer.									
Having Private Supply.									
Having Public Supply.									
Private Wells.									
Having no Water Sup-ply.									
Total Number.									
Connected with Sewer.									
Having Public Supply.									
Private Supply.									
Having no Water Sup-py.									
Total Number.									
Number on which there are Structures or Buildings but no Dwellings.									
Number of Dwellings but no Buildings.									
Number of Dwellings throughout the Year.									
Number of Dwellings occupied throughout the Year.									
Number of Dwellings throughout the Year.									
Area (Square Miles) including Water (Square Miles),									
Per Capita.									
Per Square Mile.									
Per Mile.									
Sheep.									
Swine.									
Horses.									
Cattle.									
Poultry.									
Dogs.									

¹ Includes an area of 0.22 of a square mile of the Snake Brook watershed which was diverted in 1911.

Summary of Sanitary Inspections on the Wachusett Watershed in 1915.

DISTRICT.	Number of Premises inspected,	Classification of Cases Inspected.		Condition at End of Year.
		BARN DRAINAGE.	INDIRECT SINK DRAINAGE.	
French Brook,	88	39	2	22
Muddy Brook,	40	15	1	19
Gates Brook,	188	134	9	42
Malden Brook,	33	15	1	16
Chaffin Brook,	206	120	3	65
Amesbury Brook,	223	155	10	24
Muschopauge,	92	37	5	1
South Wachusett Brook,	87	38	2	37
Trot Brook,	35	5	-	-
East Wachusett Brook,	215	82	3	8
Stillwater River,	144	60	6	59
Waushacum,	174 ^a	77	5	-
French Hill,	34	25	3	-
Totals,	1,549	802	60	-
				68
				40
				196
				33
				200
				205
				87
				86
				34
				170
				34
				98
				1,502

11 On some premises there are two or more cases.

Lakes: Not counting 157 summer cottages at Wanabagum

Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1915.

1 On some premises there are two or more cases.

* Including 255 summer dwellings.

Wachusett Watershed.

In 1913 the city of Worcester completed the Kendall Reservoir and diverted the water from 9.35 square miles of the Wachusett watershed. The premises upon this area are not included in the 1915 census. Since 1910 premises to the number of 179 have been destroyed by fire, abandoned, removed or diverted, and 184 new premises have been constructed, making a net increase of 5 in the total number of premises. The permanent population has increased nearly 9 per cent. and is now 5,745, or 52.8 per square mile as compared with 44.7 in 1910. This increase is largely due to industrial conditions which were bad in 1910 and good this year, and to a steady growth in Holden Centre and West Boylston, where business people from Worcester are building residences. Seventeen new houses were built in these two towns the past year. At present all the mills except those at Lovellville, Dawsonville and Warren's tannery are operating at full capacity. The mill at Dawsonville has been vacant throughout the year, but it was recently bought by the Stoughton Mills Company which is intending to manufacture cloth at this mill. The tenements have been repaired and plans are being made to start the mill early in 1916.

There has been a material decrease in summer residences and population, due to the diversion of 12 cottages in the Asneburnskit Brook district, and a reduction of 57 by fire and removal in the Waushacum district. Farming upon a large scale is decreasing and the number of domestic animals grows less every year, with the exception of poultry, which has increased from 36,073 to 44,358, or nearly 23 per cent. since 1910.

Sanitary conditions upon the watershed show a steady improvement, as indicated by the reduction in the number of unsatisfactory cases. At the end of 1905 the number was 195, in 1910, 61, and in 1915, 47.

There have been only three cases of typhoid fever reported during the year; one in West Boylston, one in Holden and one in Princeton. In all cases there were proper cesspools and precautions were taken to prevent any contamination of the water supply.

The Jefferson Manufacturing Company has made extensive repairs to its tenements and has improved their sanitary condition in several cases by building new cesspools, turning surface drains into aban-

doned wells and replacing old surface privies with concrete vaults. At the lower mill the sewer line from the water closets has been re-laid under the direction of an engineer and the closets are again in use. The Summit House in the Muschopauge district, a popular summer resort, was destroyed by fire in August.

Sudbury Watershed.

There has been an increase of 875 in the population on the Sudbury watershed, or 4 per cent. since 1910. There has been a decrease of 4.3 per cent. or 5.6 per square mile in the number of people residing in houses not connected with sewers conveying the drainage outside the watershed. The number of premises where the sink drainage runs upon the surface of the ground has been reduced from 694 to 516. The unsatisfactory cases have been reduced from 65 to 41. Farming operations are on the decline. There has been a decrease in the number of domestic animals, with the exception of poultry, which has increased over 28 per cent.

There were 8 cases of typhoid fever reported on the watershed during the year; 5 in Marlborough and 1 each in Westborough, Southborough and Ashland. In all cases precautions were taken to prevent the pollution of the water.

Cochituate Watershed.

There has been an increase of 2,393 in the population on the Cochituate watershed, or 16 per cent. since 1910. Early in 1911 the drainage from 0.22 of a square mile of the Snake Brook watershed, which includes the most densely populated part of Cochituate Village, was diverted from the Cochituate watershed. On this area there were 146 premises with a population of 707 in 1910. In 1913 Mr. Charles W. Dean moved his business from Cochituate to his new shoe shop in Natick, and to-day there is no manufacturing in the village. The decrease in population resulting from these changes was 852. There has been a decrease of 17.2 per cent. or 42.2 per square mile in the number of people residing in houses not connected with the sewers. The number of premises where the sink drainage runs upon the surface of the ground has been reduced from 205 to 174 and the unsatisfactory cases have been reduced from 39 to 7. Poultry has increased nearly 43 per cent. on this watershed but the number of all other domestic animals has been materially reduced.

There were 7 cases of typhoid fever reported on this watershed during the year; 5 in Framingham and 2 in Natick. All necessary precautions were taken to prevent the pollution of the water.

PROTECTION OF THE WATER SUPPLY BY FILTRATION.

On the Wachusett watershed the surface water from an area of 525 acres in the village of Sterling has been filtered at the Sterling filter-beds before being discharged into a water course from which it finally enters the Wachusett Reservoir. The sewage from the Worcester County Training School has been purified at the filter-beds on Beaman Street in West Boylston. The sewage from the summer residences at Gates Terrace, just outside the camp grounds at Sterling Junction, was filtered from April 14 to November 6. The cost of maintaining all of these filters was \$762.94.

On the Sudbury watershed the surface water from an area of 2 square miles of the thickly settled portion of the city of Marlborough has been filtered at the Marlborough Brook filter-beds before entering the Sudbury Reservoir, with the exception of about 5,800,000 gallons on January 18 and 19. Diluted sewage from the Marlborough main sewer was received at the combined storage and filter-bed on Farm Street on August 4 and 5, and ground water from the sewer underdrain on August 6 and 7 and from August 22 to 28. The cost of maintaining the filters was \$2,194.09.

On the Cochituate watershed the surface water from an area of about 1 square mile of the thickly settled portion of the town of Natick was pumped to filter-beds and filtered before entering Lake Cochituate, with the exception of 1,100,000 gallons from Pegan Brook on January 18, and the overflow from the intercepting ditch on 7 days in January, 7 days in February, 1 day in July, 4 days in August and 1 day in December, amounting to 30,100,000 gallons. The pumping station was operated during 272 days and 404,405,000 gallons, equivalent to an average of 1,108,000 gallons per day for the entire year, was pumped to the filters. The cost of operating the pumping station and maintaining the filters was \$3,965.78, which is equivalent to a cost of \$9.81 per million gallons filtered.

Since July 1 in all cases where the surface water flow exceeded the capacity of the filters and water flowed into the reservoirs without filtration, the unfiltered water was sterilized with a solution of calcium hypochlorite, which is now kept on hand at all filters for this purpose.

IMPROVEMENT OF WATERSHEDS.

The ditches which are maintained in the swamps on the watersheds for improving the quality of the water, have been cleaned and the weeds and brush mowed for a width of 10 to 20 feet on both sides. The total length of these ditches is 36.40 miles, of which 27.46 miles have been cared for by the Wachusett Department at a cost of \$1,502.55, and the remaining 8.94 miles have been cared for by the Sudbury Department at a cost of \$348.00.

For the protection of the water supply 80.256 acres of land have been acquired in the Wachusett watershed in Holden, Sterling and West Boylston, including the picnic grounds on Middle Waushacum Pond in Sterling, and 2.498 acres of land have been acquired in that portion of West Boylston known as "The Settlement" for the proposed improvement of Gates Brook. A preliminary ditch has been excavated at this place for a length of 500 feet at a cost of \$313.44.

For the protection of the water supply on the Sudbury watershed 14.74 acres of land were acquired at Framingham Reservoir No. 3 in Framingham and 3.50 acres at Whitehall Reservoir in Hopkinton.

FORESTRY.*Wachusett Department.*

About 78 acres of land covered with undesirable trees and brush was cleared, preparatory to planting, at a net cost of \$914.64. At a cost of \$1,502.52, about 140 acres of the reservoir marginal lands was planted with 171,900 three and four-year-old white pine seedlings from our Oakdale nursery, about one-half of which was raised from seed, the remainder being received from the State nursery at Amherst when one year old.

In connection with the plan to establish shade trees along our property on the highways bordering the reservoir, 1,022 sugar maple saplings were set out along 6½ miles of highway, to replace trees set out in former years that had failed. The saplings were obtained from the woods on our property and the cost of the work was \$421.63.

Undesirable trees and other growth were cut from 180 acres of land where we have a growth of young white pines from 5 to 8 years old at a cost of \$10.36 per acre. Undesirable trees were cut from an area of about 11 acres grown to chestnut, red and white oak and

white birch at a cost of \$41.50 per acre. Undesirable trees and underbrush were cut on a strip about 100 feet in width along the Clinton-Boylston highway in Boylston, for a distance of 3.8 miles at a cost of \$1,440.17, and 450 feet of new forest road was constructed and 950 feet of old forest road repaired for use as access roads to white pine plantings and wooded areas.

The expenditures for protecting the wooded areas from gypsy moths, the pine tree weevil and tent caterpillars were \$2,996.94, and the net cost of the work of combating the chestnut bark disease was \$304.31.

The necessary care has been given to both the Oakdale and North Dike nurseries and at the end of the year they contained the following trees:—

Oakdale Nursery, area 3.9 acres:—

1-year-old white pine seedlings, in seed beds,	.. . . .	50,350
4-year-old white spruce, in transplant beds,	.. . . .	13,550
1-year-old Norway pines,	.. . . . .	215
3-year-old red pines,	.. . . . .	215
4-year-old sequoias,	.. . . . .	120
		64,450

North Dike Nursery, area 2.0 acres:—

3-year-old white pines (Amherst stock),	.. . . .	96,800
3-year-old white pines (Keene stock),	.. . . .	14,400
		111,200
		175,650

Fire patrol service was maintained throughout the marginal lands of the Wachusett Reservoir on Sundays and holidays during the spring and fall of the year for the protection of the improved timber stands and young white pine forests. No fires of any consequence occurred on Water Works property, but two fires on adjacent property threatened serious damage and but for the efficiency of the power sprayer as a fire-fighting apparatus would undoubtedly have caused considerable damage.

About 55 acres of Wachusett Aqueduct land bordering on the open channel, which was grown to scrub, sprout, briars and weeds was cleared and planted with 52,575 3-year-old white pine seedlings and 10,800 spruce seedlings raised in the Oakdale nursery. The preparatory clearing cost \$885.39, the planting of the trees \$533.32, and during the past fall the brush and weeds have been mowed from the area at a cost of \$455.69.

Sudbury Department.

At the Sudbury Reservoir about 500 feet of forest road was cut on Pine Hill, and at the nursery the beds have been kept free from weeds and a fire guard has been kept plowed and harrowed around the beds.

Early in the spring 1½ acres of newly plowed land was prepared for transplanting seedlings from the State nursery at Amherst. There are now in the nursery 56,000 4-year-old pines and 50,000 2-year-old spruce seedlings which will be ready for transplanting next spring.

At the Sudbury Reservoir 57 acres of land was cleared of trees and brush for planting, 6 acres at the Ashland Reservoir and 3 acres at Lake Cochituate. The area cleared at the Ashland Reservoir was covered with a small growth of chestnut trees infested with the chestnut bark disease.

During the year plantings were made as follows:—

At Sudbury Reservoir 36,600 3-year-old seedlings were set out from the nursery and 29,875 4-year-old seedlings were set out as received from Amherst; at Framingham Reservoir No. 3 600 white pine seedlings were set out on the Hessel and Parker lands; at Ashland Reservoir 1,500 white pine seedlings from the Sudbury nursery were set out at the head of the reservoir, and 9,000 3-year-old pine seedlings from the Sudbury nursery and 5,300 from the State nursery were set out at Hopkinton Reservoir below the dam. At Lake Cochituate 700 small pines and 2,500 4-year-old seedlings were set out as received from Amherst on the north shore of Snake Brook. On the Sudbury Aqueduct land 150 pines were set out on the slope of the cut near Duncklee Street in Newton in connection with the improvement of the land at this place. On the Cochituate Aqueduct land there were planted 14,000 3-year-old pines from the nursery at Sudbury Reservoir and 6,250 4-year-old pines as received from the State nursery at Amherst along both slopes of the aqueduct between Morse's Pond and the Boston & Albany Railroad. On the Weston Aqueduct there were planted 850 3-year-old pines at the White place in Nobscoot and 2,000 east and west of School Street in Wayland from the Sudbury nursery, and 2,350 4-year-old pines east of Millwood Street in Framingham, 1,625 at the White place and 10,300 in the sand pit near Gaging Chamber No. 2 as received from Amherst.

The expenditures for protecting the wooded areas on the reservoir and aqueduct lands from gypsy and browntail moths and tent caterpillars and the pine tree weevil at Sudbury and Ashland reservoirs were \$3,053.05.

There were 19 fires in the lands in the Sudbury Department, all of which occurred during extremely dry weather in March and April. Several were caused by sparks from locomotives, several by fires spreading from adjacent lands which were being burned over and one by sparks from a steam road roller. The cause of the others is not known. The total damage was a loss of 18,700 white pines 3 to 5 years old, 100 arbor-vitæ trees, several small chestnut and oak trees and about 1,000 feet of old fence boards and hard pine plank.

Distribution Department.

Gypsy and browntail moths and elm leaf beetles have been destroyed on the Water Works lands at the distribution reservoirs. The expenditures for this work were \$2,880.09. Some planting has been done at the Chestnut Hill, Weston, Spot Pond and Fisher Hill reservoirs.

DISTRIBUTION RESERVOIRS.

The locations, capacities and elevations of the distribution reservoirs of the Metropolitan Water Works are shown by the following table:—

DISTRIBUTION RESERVOIRS AND LOCATIONS.	Elevation of ¹ High Water.	Capacity in Gallons.
Low Service:—		
Spot Pond, Stoneham and Medford,	163.00	1,791,700,000
Chestnut Hill Reservoir, Brighton District of Boston,	184.00	300,000,000
Weston Reservoir, Weston,	200.00	200,000,000
Mystic Reservoir, Medford,	157.00	26,200,000
Northern High Service:—		
Fells Reservoir, Stoneham,	271.00	41,400,000
Bear Hill Reservoir, Stoneham,	300.00	2,450,000
Northern Extra High Service:—		
Arlington Standpipe, Arlington,	442.00	550,000
Southern High Service:—		
Fisher Hill Reservoir, Brookline,	251.00	15,500,000
Waban Hill Reservoir, Newton,	264.50	13,500,000
Forbes Hill Reservoir, Quincy,	193.00	5,100,000
Forbes Hill Standpipe, Quincy,	251.00	330,000
Southern Extra High Service:—		
Bellevue Reservoir Steel Tank, West Roxbury District of Boston,	375.00	2,500,000
Total,	-	2,899,230,000

¹ Elevation in feet above Boston City Base.

By arrangement with the city of Chelsea a portion of the maintenance of its reservoir on Powder Horn Hill is assumed by the department, and the reservoir is used by the department when necessary in connection with the supplying of water to the northern high-service district. This reservoir has a capacity of 1,000,000 gallons with high-water line at elevation 196.6.

Water is delivered into the Chestnut Hill Reservoir from the storage reservoirs by gravity through masonry aqueducts and is pumped from this reservoir into the low-service pipe lines and reservoirs and into the southern high-service pipe lines and reservoirs.

Water is delivered into the Weston Reservoir through the Weston Aqueduct by gravity and is delivered from this reservoir into the low-service district without pumping.

Water for the northern high-service district is pumped from Spot Pond to the Fells and Bear Hill reservoirs. For the northern extra high-service district it is pumped from the low-service pipe lines to the steel tank at Arlington Heights and for the southern extra high-service it is pumped from the southern high-service pipe lines to the steel tank on Bellevue Hill in West Roxbury.

Chestnut Hill, Fisher Hill and Waban Hill Reservoirs.

On account of the adjacent locations of the Chestnut Hill, Fisher Hill and Waban Hill reservoirs the grounds and structures at these reservoirs are maintained by a force with headquarters at the Chestnut Hill Reservoir. At the Chestnut Hill and Waban Hill reservoirs the gate-houses were cleaned and painted on the inside and the exterior woodwork was painted where necessary, and considerable work was done in resurfacing walks and haying.

At the Chestnut Hill Reservoir the Lawrence basin has not been used during the year. The driveways have been resurfaced, the lower section of the Cochituate Aqueduct 3,000 feet in length, from the intermediate gate-house to Webber's waste-weir, was cleaned in October, and for renewing the fence along Beacon Street 104 reinforced concrete fence posts have been made. The cost of patrolling the shores of this reservoir to prevent pollution of the water by the large number of people who visit the reservoir in summer was \$572.98.

The Fisher Hill Reservoir was in use throughout the year. The grounds and gate-houses have received the usual attention.

Weston Reservoir.

The attendant and three men have been employed at this reservoir the greater part of the year and the usual work of caring for the gate-houses and screens, disposing of leaves, weeding ditches and beaches was performed. A heavy growth of water grass was removed from the open channel at the upper end of the reservoir.

George Mackie, the attendant at this reservoir since October, 1905, was accidentally drowned in the screen chamber April 12. The covers of the screen well were left off by one of his assistants during the afternoon and Mr. Mackie entering the screen chamber about nine o'clock in the evening without a light walked into the open well. His body was recovered from the aqueduct the following day about 65 feet from the screen chamber. Ephraim A. Desmond, who had formerly been employed as Mr. Mackie's assistant, has been in charge of the work since his death. Mrs. Mackie continued to live in the attendant's house until July 12; since then the house has not been occupied.

Electric service has now been installed at the screen chamber. The wiring is arranged so that unlocking the door lights four electric lamps; three other lamps, controlled by a switch, were installed to furnish additional light in the interior of the chamber. Two lamps are also provided at the two exterior corners of the building near the reservoir to furnish illumination when skimming leaves from the surface of the water at the inlet to the screen chamber. The cost of the installation was \$505.11.

Spot Pond, Fells and Bear Hill Reservoirs.

These reservoirs are located near together in the Middlesex Fells Reservation of the Metropolitan Park System and are maintained by a force with headquarters at Spot Pond. The interiors of all the gate-houses have been cleaned and painted during the year. At Spot Pond 28 new screens have been made for use in the easterly gate-house. Considerable time has been spent cutting out trees and underbrush from wooded areas and repairing the riprap at Spot Pond. Two fires occurred on the Water Works land during the year which were promptly extinguished, and practically no damage resulted therefrom. The cost of patrolling the lands to prevent pollution of the water supply by the large number of people who visit

the shores of the reservoirs during the summer was \$1,294.86. The motor boat was used and blank cartridges were fired to drive off the ducks and gulls which frequent Spot Pond. They were in largest number in December, when 2,200 ducks and 1,950 gulls were on the pond in one week.

During October and November 1,730 feet of 15-inch and 450 feet of 12-inch vitrified clay pipe and 295 feet of open channel were constructed to divert from Spot Pond to Quarter Mile Pond the surface water drainage from an area of 38 acres of land located east of the pond near the New England Sanitarium, a large portion of which was under cultivation. The work was done under a contract with Thomas Russo & Company, and cost \$3,683.22. A parcel of land containing 2.124 acres, located on the easterly side of Woodland Road and included in the diverted area, was purchased from William L. Henry in August.

Arlington, Bellervue, Forbes Hill and Mystic Reservoirs.

The new steel tank on Bellevue Hill was put into service January 22 and remained in use until March 25 when it was drained for painting. It was in service again from July 3 to September 30 and has since been out of service in connection with the construction of the masonry tower around the tank.

The Mystic Reservoir has not been used during the year. It was cleaned between May 30 and June 15 and 128 cubic yards of sediment was removed at a cost of \$586.42.

The other distribution reservoirs were given the usual attention.

DISTRIBUTION PIPE LINES.

The length of the distribution pipe lines owned and operated by the department at the close of the year is 122.24 miles, which is an increase of 3.19 miles during the year.

Extensions and Relocations by Maintenance Force.

The 48-inch main in Clinton Road, Brookline, was lowered for a distance of 348 feet so that the cover over the top of the pipe bells is now at least 3 feet, where it was formerly 1½ to 2½ feet, at a cost of \$1,504.79, which was paid by the town of Brookline in consideration for permission to lay out Clinton Road in the Water Works land over the pipe line.

A 4-inch connection, provided with a 4-inch x 2-inch Hersey detector meter, was installed at the junction of South and Main streets in Stoneham, and a 4-inch fire pipe was laid at Wellington Bridge in Somerville for the Metropolitan Park Commission.

Pipe Bridges.

Substantial repairs have been made in the pipe bridges over steam railroad tracks at College Avenue in Medford and Massachusetts Avenue in Cambridge, and minor repairs have been made at other pipe bridges. At the pipe bridge on Chestnut Hill Avenue in Brookline, which was repaired in 1914, the 36-inch pipe has been enclosed in a wooden box.

Breaks and Leaks.

On August 16 a spherical joint in the 12-inch flexible jointed pipe line under the Neponset River at West Street, in Hyde Park, opened in the channel which had been dredged by the State Department of Health early in the year, producing a vigorous leak which necessitated shutting off the main and pumping the water for the Milton southern extra high-service through the city of Boston mains in Hyde Park for a period of ten days. The pipes were pulled into position by means of cables connected to two differential blocks anchored on shore and the joint was recalked by a diver. The cost of the work was \$458.73.

On November 6 a break occurred in the 48-inch Weston Aqueduct Supply Main in Commonwealth Avenue at Auburn Street, Newton. This pipe was laid in 1902 in deep cut, the bottom of which was in ledge rock, and the cover over the top of the pipe was 14 feet. The pipe was crushed by the heavy weight above being concentrated on the small bearing surface where the pipe rested upon a projecting point of rock which was not excavated to a sufficient depth when the pipe was laid. The water from the break flooded the street to a depth of about 2 feet and entered the cellars of six houses and the basement of a church to a depth of from a few inches to several feet. In making repairs concrete was built up around the lower half of the pipe to distribute the weight evenly over a large bearing surface. All damages resulting from the break have been repaired with the exception of some seeding and cleaning up of lawns, which has been deferred until spring. The total expenditures on account of the break amount to \$4,692.41.

On November 9 a break occurred in the 6-inch cement main in the Metropolitan Water Works land near the old Mystic Pumping Station in Somerville. The cost of repairs was \$83.62.

There were 14 leaks at wooden joints and 21 at lead joints which cost \$1,262.41 for repairs.

Meters, Regulating Valves and Recording Pressure Gages.

There are now 59 Venturi meters, ranging in size from 6 inches to 48 inches in diameter, 5 4-inch and 6-inch detector, 3 disc and 1 torrent Hersey meters installed for use in measuring the quantity of water supplied from the distribution pipe lines. The 8 pressure regulating valves, installed for use in reducing the pressure of the water delivered to portions of Chelsea, East Boston and Hyde Park, and to Nahant, Revere, Swampscott and Winthrop have been kept in good order. Recording pressure gages have been maintained at 22 stations on the Metropolitan Water Works, and the table on page 196, showing elevation of the hydraulic grade line in feet above Boston City Base at these stations for each month during the year, has been prepared from the charts.

Electrolysis.

Electric measurements to determine the probable extent of electrolytic action upon our pipes were taken over the entire distribution system during the latter part of the year. As in former years, the results show differences of electric potential and electric currents of considerable magnitude resulting from the operations of the electric railways. No excavations have been made during the year to determine the extent of the electrolytic corrosion of the pipes, but the policy has been continued of installing wooden insulating joints about 500 feet apart on all new pipe lines to prevent the accumulation of large electric currents on the pipes.

CLINTON SEWAGE DISPOSAL WORKS.

Pumping Station.

The Clinton sewerage pumping station was operated throughout the year. The quantity of sewage pumped to the filter-beds averaged 941,000 gallons per day, which is 81,000 gallons per day less than in 1914. This reduction is probably due in large measure to the ground water leakage into the sewers being less in 1915 than in

1914. All of the pumping was done with the motor-driven 12-inch DeLaval centrifugal pump. New cast-iron moving and stationary rings were installed in the pump February 25, May 6 and December 1. A spare composition runner and steel shaft were purchased for use in case of accident and when making repairs.

The Clinton sewerage pumping statistics are as follows:—

Total pumpage (gallons),	343,612,000
Average pumpage (gallons per day),	941,000
Electric energy used (kilowatt hours),	113,008
Pumpage per kilowatt hour (gallons),	3,041
Average lift (feet),	47.5
Efficiency of pumping unit and transmission line (per cent.),	50.5
Coal used for burning sludge and heating (pounds),	85,800
Cost of pumping:—	
Labor,	\$1,123 00
Electric energy at \$5.30 per thousand kilowatt hours,	598 94
Coal for burning sludge and heating,	194 92
Repairs and supplies,	304 31
 Total for station,	 \$2,221 17
Cost per million gallons,	\$6.46
Cost per million foot gallons,	0.136

Filters.

The filter-beds and settling basins were operated from January 1 to April 10 and from October 20 to December 31 in practically the same manner as during the preceding 7½ years, which was to allow sedimentation to take place in the 8 settling basins before applying the sewage to the filters. During this period only 2 basins were used at a time, each pair being used continuously for about one month, the effluent being applied to the 25 1-acre filter-beds at regular intervals. From April 10 to October 20 the settling basins were discontinued and sewage was applied directly to the sand filters. The sewage received at the beginning and end of each day's operation, which contained a larger proportion of suspended matter than the remainder of the sewage, was applied to the beds located at the greatest distance from the nearby highway. This arrangement was followed to see if the odor from the sewage, which was the cause of complaints during the previous summer by persons passing along the highway, would be eliminated, as it was believed that the odors

resulted from the decomposition of the sewage in the settling basins. The odors were practically eliminated by this operation but the efficiency of filtration appears to have been reduced while the cost of operation has been increased.

The average results of chemical analyses of the sewage and effluent from the filters for the four years 1906 to 1909, inclusive, prior to the construction of the additional underdrains and of the distributors at the filters, for the four years 1911 to 1914, inclusive, after the improvements were completed, for 1914 when the settling basins were used throughout the year and for 1915 with the settling basins out of service during the summer, are given in the following table:—

[Parts per 100,000.]

	Average of Four Years, 1906-09.	Average of Four Years, 1911-14.	1914.		1915.		
			July to Decem- ber.	Whole Year.	Janu- ary to June.	July to Decem- ber.	Whole Year.
Albuminoid ammonia, sewage,	.7540	1.3125	1.6233	1.3775	1.4733	1.3967	1.4350
Albuminoid ammonia, effluent,	.0768	.06225	.0896	.0758	.1150	.0719	.09347
Reduction, per cent., . . .	89.7	95	96	94	92	95	93.5
Oxygen consumed, sewage,	7.045	10.3208	12.8000	10.825	11.2333	7.833	9.5333
Oxygen consumed, effluent,	1.085	.61765	.4434	.5786	1.1700	—	—
Reduction, per cent., . . .	89.5	94	96	94.5	90	—	—
Free ammonia, sewage,	4.1617	4.60718	4.4483	4.1658	4.4900	3.0633	3.7867
Free ammonia, effluent,	1.3134	.48038	.1070	.3345	.7615	.4234	.5924
Reduction, per cent., . . .	67.5	90	98	92	83	86	84
Nitrogen as nitrates, effluent,	.1724	1.13608	1.4980	1.0559	.7822	.6982	.7152
Iron, effluent,	1.9807	.2620	.0306	.0802	.2373	.3790	.30815

The cost of maintaining the filter-beds during 1915 was as follows:—

Labor, . . . . .	. . . . .	\$5,033 72
Supplies and expenses, . . . . .	. . . . .	222 35
		<hr/>
		\$5,256 07
Cost per million gallons filtered, . . . . .	. . . . .	\$15 31

WACHUSSETT POWER STATION.

The hydro-electric power station at the Wachusett Dam was operated during 241 days. The output has varied from the minimum amount which the Connecticut River Transmission Company is required to take under its contract up to the full capacity of the plant. Of the total quantity of water discharged into the Wachusett Aqueduct 90.2 per cent. was used for the development of energy. The power station statistics are as follows:—

Energy sold to Connecticut River Transmission Company (kilowatt hours),	4,825,541
Energy used at power station (kilowatt hours),	12,261
Energy used at sewerage pumping station (kilowatt hours),	113,008
<hr/>	
Total energy (kilowatt hours),	4,950,810
<hr/>	
Water used (gallons),	23,151,700,000
Average effective head (feet),	89.6
Energy developed per million foot gallons (kilowatt hours),	2.3866
Efficiency of station (per cent.),	75.95
<hr/>	
Earnings:—	
Energy supplied Connecticut River Transmission Company at \$5.30 per thousand kilowatt hours,	\$25,575 37
Labor supplied Connecticut River Transmission Company,	13 00
Energy used at the power station and at the sewerage pumping station, credited at \$5.30 per thousand kilowatt hours,	663 92
<hr/>	
\$26,252 29	
Cost of operating station:—	
Labor,	\$4,804 13
Fuel for heating building,	75 00
Repairs and appliances,	446 34
Taxes,	2,800 00
<hr/>	
8,125 47	
Net earnings,	\$18,126 82
Net earnings per thousand kilowatt hours developed,	\$3.661

ENGINEERING.

The engineering force has made studies, plans and estimates for various projects and improvements that have been considered during the year in connection with the maintenance of the works, and has also made surveys and plans of sanitary conditions at premises on the Wachusett watershed, surveys and plans for land purchases and takings, record plans of Water Works lands and structures, current meter gagings, tests of meters and analyses of coal and oil. The yields of the watersheds have been calculated, hydraulic and meteorological and other records have been kept, and the recording pressure gages have been cared for.

Appended to this report are tables giving the amount of work done and other information relative to contracts, a statement of cement tests, a series of tables relating to the maintenance of the Metropolitan Water Works, including the rainfall, yield of sources of supply, consumption of water in the different districts, the number of service pipes, meters and fire hydrants in the Metropolitan Water District, and a summary of statistics for the year 1915.

Respectfully submitted,

WILLIAM E. FOSS,
Acting Chief Engineer.

BOSTON, January 1, 1916.

REPORT OF ENGINEER OF SEWERAGE WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — The following report of the operations of the Metropolitan Sewerage Works for the year ending December 31, 1915, is respectfully submitted: —

ORGANIZATION.

The Engineer has charge of the design and construction of all new works, and of the maintenance and operation of all the works controlled by the Metropolitan Water and Sewerage Board for removing sewage from the twenty-five municipalities which comprise the Metropolitan Sewerage Districts.

The Engineer has had the following assistants: —

HENRY T. STIFF,	<i>Division Engineer, in charge of office and drafting room and of the construction work.</i>
CLARENCE A. MOORE,	<i>Assistant Engineer, in charge of maintenance studies and records and of construction work on the North Metropolitan System.</i>
ARTHUR F. F. HASKELL,	<i>Assistant Engineer, in charge of survey work and field work in connection with the Wellesley extension construction.</i>
RALPH W. LOUD,	<i>Assistant Engineer, in charge of survey work and field work in connection with the Wellesley extension construction.</i>
GEORGE W. WOOD,	<i>Assistant Engineer, on Malden River siphon and Deer Island extension.</i>

In addition to the above, the number of engineering and other assistants employed during the year was 17, which includes 2 instrumentmen, 6 inspectors, 3 draftsmen, 4 rodmen and engineering assistants and 2 stenographers.

METROPOLITAN SEWERAGE DISTRICTS.

AREAS AND POPULATIONS.

During the year the town of Wellesley has been admitted to the South Metropolitan Sewerage District, as provided in Chapter 343 of the Acts of 1914.

The populations of the districts, as given in the following table, are based on the census of 1915.

Table showing Ultimate Contributing Areas and Present Estimated Populations within the Metropolitan Sewerage Districts, as of December 31, 1915.

	CITY OR TOWN.	Area (Square Miles).	Estimated Population.
North Metropolitan District.	Arlington,	5.20	15,300
	Belmont,	4.66	8,370
	Boston (portions of),	8.45	108,080
	Cambridge,	6.11	109,660
	Chelsea,	2.24	44,380
	Everett,	3.34	38,410
	Lexington, ¹	5.11	4,520
	Malden,	5.07	49,680
	Medford,	8.85	31,450
	Melrose,	3.73	17,110
	Revere,	5.86	26,140
	Somerville,	3.96	88,280
	Stoneham,	5.50	7,550
	Wakefield,	7.65	12,980
	Winchester,	5.95	10,170
	Winthrop,	1.61	13,180
	Woburn,	12.71	16,530
			90.50
			601,810
South Metropolitan District.	Boston (portions of),	24.96	245,170
	Brookline,	6.81	34,250
	Dedham, ¹	9.40	11,180
	Milton,	12.59	8,750
	Newton,	16.88	43,620
	Quincy,	12.56	41,490
	Waltham,	13.63	30,540
	Watertown,	4.04	16,970
	Wellesley,	9.89	6,610
		110.76	438,580
Totals,			201.26
			1,040,390

¹ Part of town.

METROPOLITAN SEWERS.

SEWERS PURCHASED AND CONSTRUCTED AND THEIR CONNECTIONS.

During the year there have been built 1.695 miles of Metropolitan sewer within the sewerage districts, so that there are now 108.830 miles of Metropolitan sewers. Of this total, 9.642 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts, the remaining 99.188 miles of sewers and other works having been constructed by the Metropolitan boards.

The locations, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the systems:—

NORTH METROPOLITAN SEWERAGE SYSTEM.

Location, Length and Sizes of Sewers, with Public and Special Connections.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1915.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Boston:— Deer Island,	5' 0" to 9' 0", . . .	1.402	4	Shoe factory, . . .	-
East Boston,	9' 0" to 1' 0", . . .	5.467	25	Middlebrook Wool-combing Co., . . .	1
Charlestown,	6' 7"×7' 5" to 1' 0", . . .	3.292	14	Navy Yard, . . .	1
Winthrop,	9' 0",	2.864	18	Almshouse, . . .	1
Chelsea,	8' 4"×9' 2" to 1' 10"×2' 4", . . .	5.230	13	Private building, . . .	1
Everett,	8' 2"×8' 10" to 4' 8"×5' 1", . . .	2.925	7	Club house, . . .	1
Malden,	4' 6"×4' 10" to 1' 0", . . .	5.844 ¹	33	Fire Department Station, . . .	1
Melrose,	4' 6"×4' 10" to 10", . . .	6.099 ²	87	Private building, . . .	174
				Private buildings, . . .	114
				Factory, . . .	1
				Railroad station, . . .	1
				Park Department bath house, . . .	1

¹ Includes 1.84 miles of sewer purchased from the city of Malden.

² Includes .736 of a mile of sewer purchased from the city of Melrose.

North Metropolitan Sewerage System — Concluded.

Location, Length and Sizes of Sewers, with Public and Special Connections
— Concluded.

¹ Includes 2.631 miles of sewer purchased from the town of Arlington.

3 The Metropolitan sewer extends but a few feet into the towns of Belmont and Wakefield.

- Includes 2,787 miles of Mystic valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.

SOUTH METROPOLITAN SEWERAGE SYSTEM.

Location, Length and Sizes of Sewers, with Public and Special Connections.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1915.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation
Boston:— Back Bay, . . .	6' 6" to 8' 9", . . .	1.500	15	Tufts Medical School, . . .	1
Brighton, . . .	5' 9"×6' 0" to 12", . . .	6.010	15	Private house, . . .	1
Dorchester, . . .	3'×4' to 2' 6"×2' 7", . . .	2.870	13	Administration Building, . . .	1
Hyde Park, . . .	10' 7"×11' 7" to 4' 0"×4' 1", . . .	4.537	18	Boston Park Department, . . .	1
Roxbury, . . .	6' 6"×7' to 4' 0", . . .	1.490	—	Simmons College buildings, . . .	1
West Roxbury, . . .	9' 3"×10' 2" to 12", . . .	7.000	14	Art Museum, . . .	2
Brookline, . . .	6' 0"×7' 0" to 8", . . .	2.540	12	Abattoir, . . .	3
Dedham, . . .	4'×4' 1" to 8' 9"×8' 10", . . .	2.350	7	Chocolate works, . . .	2
Hull, . . .	60" pipe, . . .	0.750	—	Machine shop, . . .	1
Milton, . . .	11'×12' to 8", . . .	3.600	22	Paper mill, . . .	1
Newton, . . .	4' 2"×4' 9" to 1' 3", . . .	2.911	6	Private buildings, . . .	3
Quincy, . . .	11' 3"×12' 6" to 24" pipe, . . .	6.345	14	Lutheran Evangelical Church, . . .	1
Waltham, . . .	3' 6"×4' 0", . . .	0.001	1	Private buildings, . . .	2
Watertown, . . .	4' 2"×4' 9" to 12", . . .	0.750	5	Private building, . . .	2
Needham, ⁴ Wellesley, ⁷ . . .	2' 0"×2' 3", . . .	1.455	—	Metropolitan Water Works blow-off, . . .	6
		45.139	142	Factories, . . .	1
				Stanley Motor Carriage Co., . . .	2
				Knights of Pythias building, . . .	1

¹ Includes .355 of a mile of sewer purchased from the city of Boston.

* Includes .446 of a mile of pipe and concrete sewers built for the use of the city of Boston; also .026 of a mile of sewer purchased from the town of Watertown.

³ Includes 1.24 miles of sewer purchased from the city of Boston.

⁴ Includes .158 of a mile of pipe sewer built for the use of the town of Brookline.

⁵ Hull and Needham are not parts of the Metropolitan Sewerage District.

* Includes .025 of a mile of sewer purchased from the town of Watertown.

⁷ The Metropolitan sewer extends but a few feet into the town of Wellesley.

Information relating to areas, populations, local sewer connections and other data for the Metropolitan Sewerage districts appears in the following table:—

North Metropolitan Sewerage District.

Area (Square Miles).	Estimated Total Population.	Miles of Local Sewer connected.	Estimated Population contributing Sewage.	Ratio of Contributing Population to Total Population (Per Cent.).	CONNECTIONS MADE WITH METRO- POLITAN SEWERS.	
					Public.	Special.
90.50	601,810	743.35	542,575	90.1	297	517

South Metropolitan Sewerage District.

110.76	438,580	627.61	300,435	68.5	142	41
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Both Metropolitan Sewerage Districts.

201.26.	1,040,390	1,370.96	843,010	81.3	439	558
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Of the estimated gross population of 1,040,390 on December 31, 1915, 843,010, representing 81.3 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1,370.96 miles of local sewers owned by the individual cities and towns of the districts.

These sewers are connected with the Metropolitan systems by 439 public and 558 special connections. During the current year there has been an increase of 32.2 miles of local sewers connected with the Metropolitan systems, and 12 public and 15 special connections have been added.

CONSTRUCTION.

NORTH METROPOLITAN SEWERAGE SYSTEM.

DEER ISLAND OUTFALL EXTENSION.

Work on the extension of the Deer Island outfall, which was authorized by Chapter 344 of the Acts of 1914, was started during the year. Considerable delay was experienced in obtaining the necessary permit from the United States Government. This was not received until June 29, 1915. Immediately a contract was made for the cast-iron pipe and specials which are to be used in the extension. The particulars of this contract are as follows:—

Date of contract No. 130, August 27, 1915.

Material, 84-inch cast-iron pipe and specials, 310 tons.

Name of contractor, United States Cast Iron Pipe and Foundry Company.

At the present time these pipes are being constructed and are to be shipped early in the coming year.

SECTION 1A.—DEER ISLAND OUTFALL EXTENSION.—NORTH METROPOLITAN SYSTEM.

In connection with the construction of the outfall extension it becomes necessary to construct a temporary outfall. This consists of a reinforced concrete masonry sewer extending from Station 1+15 of Section 2 of the North Metropolitan System southeasterly across the government reservation on Deer Island to a controlling chamber at high-water line. From here the last 400 feet of this section will be constructed of 60-inch cast-iron pipe laid in a trench to a point 100 feet beyond mean low-water line. It is intended that this temporary outfall line will be left in place and at some future time extended so as to make a duplicate outfall for the North Metropolitan System. This temporary outfall sewer is known as Section 1A. Some particulars of this section and contract are as follows:—

Date of contract No. 131, October 11, 1915.

Length of section, 1,165 feet.

Name of contractor, George M. Bryne.

Average depth of cut (concrete sewer), 18 feet.

Diameter of reinforced concrete sewer, 78 inches.

Diameter of cast-iron pipe outfall, 60 inches.

Assistant Engineer in charge of construction, Clarence A. Moore.

At the present time the chamber near Station 4 is partially constructed and 173 feet of 78-inch reinforced concrete sewer has been constructed and 12 feet of 60-inch pipe has been placed.

The connection of Section 1A to Section 2 has been completed by day labor. This work consists of the construction of a branch sewer and a controlling stop-plank manhole. Considerable water was encountered most of which came from the 12-inch underdrain built under Section 2. The earth excavated consisted of sand and gravel.

SECTION 19.—MALDEN RIVER SIPHON.—NORTH METROPOLITAN SYSTEM.

Chapter 215 of the Acts of 1915 authorized the lowering of the Metropolitan sewerage siphon in Malden River, known as Section 19, North Metropolitan System, the cost of which is to be assessed upon the North Metropolitan Sewerage District. This relocation is necessary in order to comply with acts of Congress, chapters 253 of 1912 and 142 of 1915, which appropriated \$80,000 to be used in

the deepening and straightening of the channel of Malden River under the condition that the Commonwealth should relocate the Metropolitan sewerage siphon.

In accordance with a written communication received by the Board from the Directors of the Port of Boston, dated August 31, 1915, a siphon has been studied at such a depth as to allow for a 20-foot channel. The work will consist of a brick siphon constructed by compressed air process and connecting sewers in trench on pile foundations together with a head house on the Everett side of the river. The necessary permits from the Directors of the Port of Boston and from the United States Government were not received until November 1, 1915. Immediately a contract for the construction of this work was advertised. The particulars of this section and contract are as follows:—

Date of contract No. 132, November 16, 1915.

Length of 48-inch brick siphon and connecting sewers, 420 feet.

Name of contractor, George M. Bryne.

Depth of bottom of structure below high water, 43 feet.

Assistant Engineer in charge of construction, Clarence A. Moore.

At time of writing the contractor's plant has been assembled and the shaft is partly constructed.

SOUTH METROPOLITAN SEWERAGE SYSTEM.

SECTION 43.—RELIEF OUTFALL.—SOUTH METROPOLITAN SYSTEM.

This 60-inch cast-iron pipe outfall was described in the report of 1914. It was partially completed at the end of last year and has been fully completed and put into service during this year. This pipe is designed to be used for discharge in emergency cases only and owing to its short length of 1,400 feet, it has a discharging capacity of about the same as the combined capacities of the two outfall pipes completed in 1904. This additional pipe renders the High-level sewer outfalls competent for a long period.

HIGH-LEVEL SEWER EXTENSION TO WELLESLEY.

Chapter 343 of the Acts of 1914 provided for the admission of Wellesley into the South Metropolitan Sewerage District and also for the construction of a trunk sewer connecting said town with the Neponset Valley sewer. This act was not accepted by the town of

Wellesley until March, 1915. Immediately after its acceptance studies and surveys were begun and the following line has been located.

Starting at Station 22 + 39 of Section 26, Neponset Valley sewer in West Roxbury, the line extends in a westerly direction across the Charles River into Dedham and follows in this portion in a general way a line proposed by the State Board of Health as an alternate line crossing Bridge Street and Pine Street and again crossing the Charles River. It then continues in Dedham through private lands till it again approaches the said river, thence it extends along its southern bank crossing Greendale Avenue and Dedham Avenue. Near the latter it again crosses the Charles River into the town of Needham and extends along the northerly side of the river and in a general way parallel to said river through private lands crossing Chestnut Street, South Street and the New York, New Haven & Hartford Railroad about 500 feet west of Charles River Station, continuing in private lands and crossing Central Avenue and Charles River Street and extending to a point in private land in the town of Wellesley about 10 feet north of the Needham-Wellesley town line.

This route differs from that studied by the State Board of Health in a preliminary way chiefly in the lower portion near West Roxbury where it follows in a general way the alternate line proposed by said Board. This change was made to avoid crossing the water fields of the Brookline Water Works, also to furnish sewerage outlet for a rapidly growing section in Dedham near Bridge Street and also to connect at a point where the Metropolitan sewer increases in size.

During the year that part of the line extending from Chestnut Street, Needham, to the Wellesley-Needham town line has been placed under contract and divided into four sections. These contracts are described in the order of their dates.

SECTION 106.—WELLESLEY EXTENSION.—SOUTH METROPOLITAN SYSTEM.

This section begins at a point on the northerly side of the Charles River in land of Hugh D. Scott and extends northerly through said land, land of F. Murray Forbes, land formerly belonging to Arthur W. Pope, crossing Charles River Street and through other land of

Arthur W. Pope and land of Isabella P. Shaw to a point in Wellesley about 10 feet north of the Wellesley-Needham town line.

Some particulars of this section and contract are as follows:—

Date of contract No. 123, July 29, 1915.

Name of contractor, Hugh Nawn Contracting Company.

Length of section, 4,355 feet.

Average depth of cut, 13 feet.

Dimensions of concrete sewer, 24 inches x 27 inches.

Assistant Engineer in charge of construction, Ralph W. Loud.

Considerable difficulty was experienced in the construction of this section from Station 19 + 50 to Station 37 + 0. An unusually fine gray sand was encountered about 6 feet below the surface which rendered the progress exceedingly slow and expensive. No large amount of water was found and at time of writing there yet remains to be constructed 1,095 feet. No ledge was encountered.

SECTION 105.—WELLESLEY EXTENSION.—SOUTH METROPOLITAN SYSTEM.

This section starts at a point in Central Avenue about 100 feet west of its junction with Fisher Street and extends northwesterly through land of the Walker-Gordon Laboratory Company and land of C. H. W. Foster to a point in the land of Hugh D. Scott mentioned as the beginning of Section 106.

Some particulars of this section and contract are as follows:—

Date of contract No. 124, July 29, 1915.

Name of contractor, Hugh Nawn Contracting Company.

Length of section, 4,425 feet.

Average depth of cut, 9 feet.

Dimensions of concrete sewer, 24 inches x 27 inches.

Assistant Engineer in charge of construction, Ralph W. Loud.

No difficulty was encountered in the construction of this section. A small amount only of ground water was encountered. The section, except minor surface repairs, was completed on December 31, 1915. Ledge was encountered near Station 0, Station 8 + 50 and Station 42.

SECTION 104.—WELLESLEY EXTENSION.—SOUTH METROPOLITAN SYSTEM.

This section begins at a point in private land of Mrs. Anne B. Richardson and extends westerly through said land, then through land of the Needham Tire Company partly in tunnel and crosses South Street in tunnel. From here it extends in open cut through private lands belonging to the Quinobequin Canoe Association, Walker-Gordon Laboratory Company, Joseph W. Battelle, Martha H. Burrage, Clifford M. Locke and in tunnel through lands of Heirs of John Defren and the New York, New Haven & Hartford Railroad. It then extends in open cut through other land of the Walker-Gordon Laboratory Company and land of Charles H. Harmon to a point in Central Avenue described as the commencement of Section 105.

Some particulars of this section and contract are as follows:—

Date of contract No. 133, December 22, 1915.

Name of contractor, Bay State Dredging and Contracting Company.

Total length of section, 4,300 feet.

Length in tunnel, 930 feet.

Average depth of tunnel, 26 feet.

Average depth of open cut, 13 feet.

Dimensions of concrete sewer in tunnel, 27 inches x 36 inches.

Dimensions of concrete sewer in trench, 24 inches x 27 inches.

Assistant Engineer in charge of construction, A. F. F. Haskell.

Work on this section has not been started.

SECTION 103.—WELLESLEY EXTENSION.—SOUTH METROPOLITAN SYSTEM.

This section starts at a point in Chestnut Street about 40 feet north of the bridge across Charles River and extends in a westerly direction through private lands of I. Tucker Burr, Jr., John Wells Farley, Mrs. Anne Williams, Mrs. Leslie B. Cutler and Mrs. Anne B. Richardson to a point described as the beginning of Section 104.

Some particulars of this section and contract are as follows:—

Date of contract No. 134, December 22, 1915.

Name of contractor, Bruno & Petitti.

Length of section, 5,916 feet.

Average depth of cut, 7 feet.

Dimensions of concrete sewer, 24 inches x 27 inches.

Assistant Engineer in charge of construction, A. F. F. Haskell.

Work on this section has not yet been started.

These four sections represent about one-half of the total line. Studies for the remainder are in progress and all will be under contract during the coming year.

MAINTENANCE.

SCOPE OF WORK AND FORCE EMPLOYED.

The maintenance of the Metropolitan Sewerage System includes the operation of 7 pumping stations, the Nut Island screen-house and 108.83 miles of Metropolitan sewers, receiving the discharge from 1370.96 miles of town and city sewers at 439 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force includes 167 men, of whom 101 are employed on the North System and 66 on the South System. These are subdivided as follows: engineers and other employees at the pumping stations, North Metropolitan System, 58; and on maintenance, care of sewer lines, buildings and grounds, 43 men, including foremen; South Metropolitan System, 34 engineers and other employees within the pumping stations; and 32 men, including foremen, on maintenance, care of sewer lines, buildings and grounds.

The regular work of this department, in addition to the operation of the pumping stations, has consisted of routine work of cleaning and inspecting sewers and siphons, caring for tide gates, regulators and overflows, measuring flow in sewers, inspection of connections with the Metropolitan sewers, care of pumping stations and other buildings and grounds, and the maintenance of the ferry at Shirley Gut for transporting employees and supplies in connection with the operation of the Deer Island pumping station.

In addition to these regular duties other work has been done by this department as follows:—

NEW MYSTIC SEWER.

The New Mystic sewer, authorized by Chapter 461 of the Acts of 1912, was put into operation on January 7, 1915. This relieves the congested condition of the Metropolitan sewers through the town of Winchester.

DEER ISLAND PUMPING STATION.

During the year, at this station, a new 8-inch steam main has been installed to connect the boilers with the new steam main erected in 1910. This replaces the original steam main which was constructed in 1894.

Extensive repairs have been made to pump No. 2 at this station during the year. These consist of adjusting the impeller wheel and refitting it to the 10-inch shaft, the renewal of the bronze sleeve bushing, the cutting of the shaft and the introduction of a sleeve coupling. This pump is now in good condition.

All work was done by maintenance employees.

EAST BOSTON PUMPING STATION.

During the year the roofs over the old engine house and machine shop and the new coal house have had extensive repairs. The inclination of the roofs has been increased and the tiling on the same has been relaid in Portland cement mortar with expansion joints filled with elastic cement.

The screen-house, mentioned in last year's report as under construction, was completed on February 28, 1915, excepting the floor. This consists of tile and cast-iron plates and was constructed by the maintenance employees.

The new screening machinery has been completed during the year and is in operation. The system of forced ventilation of the sewers and underground chambers for removal of dangerous gases has proved efficient and satisfactory.

An addition was made to the land holding at this station by the acquisition in fee of 7,885 square feet of land in front of the station from the East Boston Company. A lease for a strip of land about 10 feet in width on the westerly side of the pumping station lot has been arranged for with the Boston & Albany Railroad Company. The newly acquired land in front of the station has been loamed and granolithic sidewalks and curbing have been placed. Macadam surfacing has been placed in the area back of the screen-house and on a 15-foot way in front of the pumping station.

Machinery was added to the machine shop during the year in the shape of a large upright drill and a shaping machine. A wood

planer has also been placed in the carpenter and pattern shop. Labor for all the above changes and repairs has been furnished by the maintenance employees.

CHARLESTOWN PUMPING STATION.

At this station the old sheet-iron by-pass which extended between the boiler room and the chimney had become so badly corroded that it was necessary to remove it. This was replaced by a brick by-pass. In connection with this work changes were made whereby the dynamo room was materially enlarged and a new switch board has been installed.

During the year repairs have been made to the pumps at this station. Pump No. 2 shaft has been refitted with a new bronze sleeve bushing. Repairs on pump No. 3 consisted of refitting the 10-inch shaft to the impeller wheel and adjusting the latter, cutting of the shaft and the renewal of the bronze sleeve bushing and the introduction of a sleeve coupling.

All work was done by maintenance employees.

CLEANING OF OLD MYSTIC VALLEY SEWER.

That part of the old Mystic Valley sewer which was constructed by the city of Boston in 1878 which lies north of Cross Street, Winchester, has never been a part of the Metropolitan Sewerage Works. At the time of the creation of the Metropolitan Water Board in 1895 this part of the old Mystic Valley sewer became the property of said Board. During the year it has been necessary to expend considerable labor on this line for repairs and cleaning. Its condition has been very much improved.

All work was done by maintenance employees.

WARD STREET PUMPING STATION.

During the year the weir chamber and 36-inch cast-iron pipe which were used in the testing of the plant have been remodelled into a fresh water reservoir which contains enough for about 24 hours' supply in the station. Necessary piping connections have been made whereby this water can be used in case of accident to the street water-service pipes.

All work was done by maintenance employees.

NUT ISLAND SCREEN-HOUSE.

At this station a new boiler blow-off pipe has been laid from the station to the beach at the north extremity of Nut Island.

This work was done by maintenance employees.

SECTION 70. — HIGH-LEVEL SEWER.

At the time of the construction of Section 70 a 48-inch cast-iron pipe was constructed across the Metropolitan sewer for the purpose of temporarily maintaining the service of the existing City of Boston sewer in Washington Street, West Roxbury. At the completion of the Metropolitan sewer this city sewer was made tributary to it. This 48-inch pipe, however, was not at the time removed. During the present year this has been removed and the resulting necessary changes have been made in the Metropolitan sewer at this point.

This work was done by maintenance employees.

The 24-inch brick siphon mentioned in last year's report as being constructed by the Metropolitan Water and Sewerage Board for the city of Boston underneath the Metropolitan sewer at the same locality, was turned over to the custody of the city of Boston on January 8, 1915. Full payment for this construction has been received from the city of Boston.

GASOLENE IN PUBLIC SEWERS.

In compliance with the directions of the Board to make a study of the subject of gasolene in the Metropolitan sewers the following has been accomplished.

An inspector from this department has visited every municipality in the district. Lists of places where gasolene and similar oils are used have been obtained from the local authorities who, by law, are required to issue permits for the use and storage of these oils.

In all 1,451 places have been visited in accordance with lists furnished him by these local authorities. Of these 277 were found to be connected with public sewers. Separators which would conform to the requirements of this Board were found in 25 places only. At time of writing 132 places have been changed to comply with the requirements, leaving 97 others to be changed. In general the owners have made these changes without serious opposition. In one or two cases only has it been found necessary to issue peremptory orders that changes should be made.

In the city of Boston we find appliances in use which were installed for the purpose of excluding sand from the public sewers. Many of these with slight changes can be made into suitable gasolene excluders. Notices have been sent to all of the municipalities that all establishments of this kind to be constructed in the future must be supplied with excluding devices.

The accompanying tables show the situation as it exists. Without doubt there are other places where these oils are used which our inspector has not yet discovered as in some of the municipalities the records are imperfect.

TABLE SHOWING NUMBER OF PLACES WHERE GASOLENE IS USED AND PROGRESS OF WORK OF INSTALLING SEPARATORS TO JANUARY 1, 1916.

North Metropolitan Sewerage District.

CITY OR TOWN.	Number of Places visited where Gasoline is used.	Number of said Places connected with Public Sewers.	Number of Places originally having acceptable Separators.	Number of Places in which Changes have been made.	Number of Places yet to be supplied with Separators.	Remarks.
Arlington,	2	2	-	-	2	
Belmont,	-	-	-	-	-	No places connected with sewer.
Boston: —						
Charlestown District, . .	16	7	-	5	2	
East Boston District, . .	7	7	-	2	5	
Cambridge,	283	41	-	24	17	
Chelsea,	24	9	-	5	4	
Everett,	24	12	-	12	-	
Lexington,	-	-	-	-	-	
Malden,	61	18	-	14	4	
Medford,	44	10	-	6	4	
Melrose,	21	4	-	2	2	
Revere,	7	5	-	4	1	
Somerville,	133	27	8	6	13	
Stoneham,	6	2	-	1	1	
Wakefield,	4	4	-	2	2	
Winchester,	40	6	-	2	4	
Winthrop,	5	3	-	2	1	
Woburn,	6	2	-	-	2	
Totals,	683	150	8	87	64	

TABLE SHOWING NUMBER OF PLACES WHERE GASOLENE IS USED AND PROGRESS
OF WORK OF INSTALLING SEPARATORS TO JANUARY 1, 1916.

South Metropolitan Sewerage District.

CITY OR TOWN.	Number of Places visited where Gasoline is used.	Number of said Places connected with Public Sewers.	Number of Places originally having acceptable Separators.	Number of Places in which Changes have been made.	Number of Places yet to be supplied with Separators.	Remarks.
Boston:—						
Hyde Park District, .	5	5	—	3	2	
West Roxbury District, .						
Back Bay District, .	489	41	5	18	23	Most of these have sand traps only.
Brighton District, .						
Dorchester District, .						
Brookline,	91	27	9	18	—	Conditions in this town are very good.
Dedham,	2	2	—	2	—	
Milton,	—	—	—	—	—	No garages connected with public sewers.
Newton,	106	23	—	—	—	Not yet reported on.
Quincy,	10	9	—	3	6	
Waltham,	50	—	—	—	—	Not allowed to connect with public sewers.
Watertown,	15	11	3	6	2	
Wellesley,	—	—	—	—	—	No public sewers yet connected with Metropolitan Sewer.
Totals,	768	118	17	45	33	

DRAINAGE FROM TANNERIES, GELATINE AND GLUE WORKS IN WINCHESTER, WOBURN AND STONEHAM.

Five men and a foreman have been employed during a part of the year in flushing and cleaning the Metropolitan sewers through the tannery districts of Winchester, Woburn and Stoneham.

All the tanneries and glue works of the district now have settling tanks of substantial size. This method of treatment has very greatly reduced the amount of sludge material entering the Metropolitan sewers.

The following table gives details of settling tanks introduced to date, showing the operations of same with the amount of sludge collected and removed:—

Table of Semi-fluid Sludge removed from Settling Basins at the Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham, Year ending December 31, 1915.

LOCATION OF BASIN.	Basin put in Operation.	Inside Measurement of Basin (Feet).	Number of Times cleaned during the Year.	Average Quantity of fluid Sludge removed during the Year (Cubic Yards).	Total Quantity of semi-fluid Sludge removed during the Year (Cubic Yards).
Beggs & Cobb Company, Basin No. 1, .	Jan. 15, 1910	47.0 X 23.0	5	136.00	680.00
Beggs & Cobb Company, Basin No. 2, .	May 9, 1910	47.0 X 23.0	9	136.00	1,224.00
Beggs & Cobb Company, Basin No. 3, .	Oct. 19, 1911	51.0 X 25.0	5½	160.40	882.20
S. C. Parker & Son,	Aug. 1, 1910	48.3 X 23.0	1	69.88	69.88
American Hide and Leather Company, Factory D.	Nov. 15, 1910	48.0 X 23.1	4½	139.54	627.93
B. F. Kimball & Co.,	Dec. 10, 1910	47.2 X 23.0	3½	106.84	372.94
E. Cummings Leather Company, . . .	Nov. 1, 1910	45.9 X 22.6	3½	97.60	341.60
W. P. Fox & Sons,	July 12, 1910	47.8 X 22.6	5½	135.20	743.60
Thayer & Foss, ¹	Sept. 15, 1910	48.1 X 23.1	1	61.17	61.17
Bay State Leather Company, ² . . .	Jan. 9, 1911	46.8 X 22.9	2½	134.32	335.80
Van Tassell Leather Company, . . .	May 1, 1911	{ 10.2 X 14.5 43.8 X 19.5 }	1	102.00	102.00
American Glue Company,	Oct. 1, 1910	47.1 X 23.0	2½	136.36	340.90
J. O. Whitten Company, ³	1902	{ 35.5 X 24.7 67.2 X 12.0 }	7	58.74	411.18
			-	-	51.00
Total,	-	-	-	-	6,244.20

¹ Successors to T. F. Boyle & Co.

² Factory burned May 27, 1915, and abandoned.

³ Successors to Winchester Manufacturing Company.

METROPOLITAN WATER

[Pub. Doc.]

NORTH METROPOLITAN SEWERAGE SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewers connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1915.]

CITIES AND TOWNS.	Miles of Local Sewers connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection. ¹	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Areas to Ultimate Areas.	Sq. Miles.	Per Cent.
Boston (Deer Island),	0.70	Separate,	-	-	1,280*	1,280*	-	-	-	-	100.0
Winthrop,	32.11	Separate,	2,876	4.50	12,940	13,180	1.29	1.01	86.3	86.3	86.3
Boston (East Boston),	33.09	Separate and combined,	5,018	12.70	63,720	64,800	1.16	2.18	53.2	53.2	53.2
Chelsea,	30.68	Separate and combined,	4,067	10.40	42,205	44,380	1.13	2.24	50.4	50.4	50.4
Everett,	47.10	Separate and combined,	4,959	6.90	35,720	38,410	1.97	3.34	59.0	59.0	59.0
Malden,	64.38	Separate,	6,724	6.60	48,705	49,960	3.09	5.07	69.9	69.9	69.9
Melrose,	38.41	Separate,	3,215	4.00	14,700	17,110	1.84	3.75	49.3	49.3	49.3
Boston (Charlestown),	21.22	Separate and combined,	6,390	7.50	39,615	40,000	0.67	1.11	90.3	90.3	90.3
Cambridge,	152.51	Separate and combined,	16,452	6.55	107,760	109,060	5.03	6.11	82.3	82.3	82.3
Somerville,	100.33	Separate and combined,	15,570	5.55	86,415	88,260	3.43	3.96	97.9	97.9	97.9
Medford,	63.36	Separate,	5,542	5.50	30,490	31,450	3.12	3.25	96.9	96.9	96.9
Winchester,	30.22	Separate,	1,905	5.20	9,935	10,170	1.44	5.06	92.3	92.3	92.3
Woburn,	15.08	Separate,	1,175	5.80	6,815	7,580	0.99	12.71	41.2	41.2	41.2
Stoneham,	13.32	Separate,	923	4.70	4,340	7,560	0.70	6.60	87.5	87.5	87.5
Arlington,	28.71	Separate,	2,003	6.30	12,420	15,360	1.87	6.30	90.8	90.8	90.8
Belmont,	19.08	Separate,	1,036	6.60	7,340*	8,370	1.24	4.64	87.7	87.7	87.7
Wakefield,	13.91	Separate,	738	5.50	4,060	12,980	0.58	7.65	31.3	31.3	31.3
Lexington, ²	-	Separate,	-	-	-	4,520	-	5.11	-	-	-
Revere,	39.19	Separate,	3,255	6.60	21,485	26,140	1.98	5.98	82.2	82.2	82.2
Totals,	743.35	-	80,748	6.70	542,875	601,810	31.61	90.60	90.1	94.9	94.9

¹ Estimated from assessors' statement of the number of houses in each city or town * Including 2 connections with McLean Hospital, having an estimated population of 503.

On April 1, 1915, and the population from census of 1915.

² Estimated by Supt. Carleton L. Brett of the institution on Deer Island.

* Exclusive of Mystic Valley sewer and tanneries.

³ Lexington not connected.

SOUTH METROPOLITAN SEWERAGE SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewers connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1915.]

CITIES AND TOWNS.	MILES OF LOCAL SEWERS CONNECTED.	SEPARATE OR COMBINED.	NUMBER OF CONNECTIONS WITH LOCAL SEWERS.	ESTIMATED NUMBER OF PERSONS SERVED BY EACH HOUSE CONNECTION. ¹	ESTIMATED POPULATION NOW CONTRIBUTING SEWAGE.	ESTIMATED PRESENT TOTAL POPULATION.	ESTIMATED AREA NOW CONTRIBUTING SEWAGE.	AREA ULTIMATELY TO CONTRIBUTE SEWAGE.	PER CENT. OF CONTRIBUTING POPULATION TO PRESENT TOTAL POPULATION.	PER CENT. OF CONTRIBUTING AREA TO ULTIMATE AREA.
Boston (Back Bay),	25.78	Separate and combined,	1,749	19.70	34,455	35,030	Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Boston (Brighton),	61.38	Separate and combined,	3,721	6.80	25,305	26,210	3.17	3.74	99.9	84.8
Brookline,	72.10	Separate and combined,	4,637	7.25	35,920	34,250	3.56	6.61	99.2	52.3
Newton,	123.58	Separate,	7,071	6.70	40,305	43,620	7.65	16.88	92.4	46.3
Watertown,	43.63	Separate,	2,565	6.30	13,585	16,970	2.26	4.04	80.1	65.9
Waltham,	47.14	Separate,	3,803	7.60	28,905	30,640	2.43	3.63	94.6	17.8
Boston (Dorchester),	55.88	Separate and combined;	5,647	8.10	45,740	75,770	2.48	4.39	60.4	50.7
Milton,	15.71	Separate and combined,	850	5.00	4,250	8,750	0.83	12.59	45.6	6.9
Boston (Hyde Park),	33.51	Separate,	2,316	7.60	17,860	20,020	1.57	4.37	97.9	34.4
Dedham,	16.78	Separate,	817	5.60	4,895	11,180 ²	0.83	9.40	40.2	8.3
Boston (Roxbury), ³	-	Separate and combined,	3,768	-	44,370 ⁴	-	-	-	-	-
Boston (West Roxbury),	57.28	Separate,	5,147	5.50	23,585 ⁴	33,770	2.59	8.92	70.6	29.0
Quincy, ⁴	74.91	-	-	-	28,310	41,490	3.22	12.56	68.2	25.6
Wellesley, ⁴	-	-	-	-	-	6,610	-	9.80	-	-
TOTALS,	627.61	-	-	42,091	7.10	300,435	438,580	31.79	110.76	68.6
										28.7

¹ Estimated from assessors' statement of the number of houses in each city or town on April 1, 1915, and the population from census of 1915.

² Part of town not included in Metropolitan Sewerage District.

³ At present connected with Boston Main Drainage System.

⁴ Including connection with institution at Austin Farm, having an estimated population of 2,000.

⁴ Wellesley not yet connected with metropolitan sewer.

Both METROPOLITAN SEWERAGE SYSTEMS.

Table showing Areas delivering Sewage to both Systems; Approximate Miles of Sewers connected; Estimated Population and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1916.]

System.	Miles of Local Sewers con- nected.	Separate or Combined.	Number of Con- nections with Local Sewers.	Estimated Number of Persons served by Each House Connection.	Estimated Population now con- tributing Sewage.	Estimated Present Total Popula- tion.	Area ulti- mately to contribute Sewage.	Ratio of Contribut- ing Area to Present Total Popula- tion.	Ratio of Contribut- ing Area to Ulti- mate Area.
North Metropolitan,	743.35	Separate and combined,	80,748	6.7	542,575	601,810	81.61	90.1	34.9
South Metropolitan,	697.61	Separate and combined,	42,091	7.1	300,455	438,980	81.79	68.5	28.7
Totals,	1,370.96	-	122,839	6.9	843,010	1,040,790	63.40	201.26	61.6

PUMPING STATIONS.

CAPACITY AND RESULTS.

The pumping stations have been operated throughout the entire year on the increased rate of wages which was in operation only seven months of the preceding year. Notwithstanding this increase the expense per million foot-gallons in the pumping stations of the north line is substantially below that of last year.

On the south line the expense is slightly in excess of last year.

During the year the pumping plants at Deer Island, East Boston and Charlestown have been extensively repaired and their efficiency increased.

Average Daily Volume of Sewage lifted at Each of the Six Principal Metropolitan Pumping Stations and the Quincy (Hough's Neck) Sewage Lifting Station during the Year, as compared with the Corresponding Volumes for the Previous Year.

PUMPING STATION.	AVERAGE DAILY PUMPAGE.			
	Jan. 1, 1914, to Dec. 31, 1914.	Jan. 1, 1915, to Dec. 31, 1915.	Increase during the Year.	
Deer Island,	Gallons. 58,700,000	Gallons. 60,392,000	Gallons. 1,692,000	Per Cent. 2.9
East Boston,	56,700,000	58,392,000	1,692,000	3.0
Charlestown,	32,600,000	33,500,000	900,000	2.7
Alewife Brook,	3,506,000	3,371,000	135,000 ¹	3.8 ¹
Quincy,	3,993,000	3,865,000	128,000 ¹	3.2 ¹
Ward Street (actual gallons pumped), .	26,718,000	26,933,000	215,000	0.8
Quincy (Hough's Neck) sewage lifting station.	84,500	177,700	93,200	110.3

¹ Decrease.

NORTH METROPOLITAN SYSTEM.

Deer Island Pumping Station.

At this station are four submerged centrifugal pumps with impeller wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons, with 19-foot lift.

Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.

Average duty for the year: 54,725,000 foot-pounds.

Average quantity raised each day: 60,392,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 4 oilers, 3 screenmen, 1 relief screenman and 1 laborer.

Coal used: New River and Sterling Elmora, costing from \$3.77 to \$4.22 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumppage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbe. per 100 lbs. Coal).
1915.						
January, . . .	2,081,500,000	67,100,000	32,000,000	128,900,000	11.43	50,600,000
February, . . .	2,025,200,000	72,300,000	51,100,000	117,100,000	11.24	50,600,000
March, . . .	1,627,200,000	52,500,000	44,600,000	62,200,000	11.14	49,300,000
April, . . .	1,633,200,000	54,400,000	46,600,000	73,200,000	10.68	53,800,000
May, . . .	1,772,700,000	57,200,000	47,300,000	80,000,000	11.07	64,000,000
June, . . .	1,463,400,000	48,800,000	38,800,000	60,100,000	10.83	58,700,000
July, . . .	2,393,200,000	77,200,000	50,400,000	137,400,000	10.92	51,200,000
August, . . .	2,403,200,000	77,500,000	50,400,000	126,100,000	10.34	54,700,000
September, . . .	1,497,100,000	49,900,000	40,200,000	59,000,000	10.64	54,100,000
October, . . .	1,594,500,000	51,400,000	43,600,000	77,700,000	10.76	58,700,000
November, . . .	1,568,400,000	52,300,000	41,400,000	79,500,000	10.85	54,600,000
December, . . .	1,987,000,000	64,100,000	45,300,000	107,600,000	11.36	56,400,000
Total, . . .	22,046,600,000	-	-	-	-	-
Average, . . .	-	60,392,000	44,300,000	92,400,000	10.94	54,725,000

Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.

Volume (22,046.6 Million Gallons) × Lift (10.94 Feet) = 241,189.8 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$16,816 92	\$0.06972
Coal,	9,901 89	.04105
Oil,	257 08	.00107
Waste,	56 64	.00023
Water,	1,461 80	.00606
Packing,	117 44	.00049
Miscellaneous supplies and renewals,	1,874 81	.00777
Totals,	\$30,486 38	\$0.12639
Labor at screens,	\$2,961 45	-

East Boston Pumping Station.

At this station are four submerged centrifugal pumps, with impeller wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons with 19-foot lift.

Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.

Average duty for the year: 74,725,000 foot-pounds.

Average quantity raised each day: 58,392,000 gallons.

Force employed: 4 engineers, 2 relief engineers, 3 firemen, 1 relief fireman, 4 oilers, 3 screenmen, 1 relief screenman, 3 helpers and 1 laborer.

Coal used: New River and Sterling Elmora, costing from \$3.77 to \$4.21 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1915.						
January, . . .	2,019,500,000	65,100,000	30,000,000	126,900,000	15.33	70,400,000
February, . . .	1,969,200,000	70,300,000	49,100,000	115,100,000	15.60	75,100,000
March, . . .	1,565,200,000	50,500,000	42,600,000	60,200,000	14.97	65,900,000
April, . . .	1,573,200,000	52,400,000	44,500,000	71,200,000	15.06	78,600,000
May, . . .	1,710,700,000	55,200,000	45,300,000	78,000,000	14.99	81,400,000
June, . . .	1,403,400,000	46,800,000	36,800,000	58,100,000	14.69	71,500,000
July, . . .	2,331,200,000	75,200,000	48,400,000	135,400,000	15.06	81,300,000
August, . . .	2,341,200,000	75,500,000	48,400,000	124,100,000	14.97	86,000,000
September, . . .	1,437,100,000	47,900,000	38,200,000	57,000,000	14.86	72,900,000
October, . . .	1,532,500,000	49,400,000	41,600,000	75,700,000	14.64	71,600,000
November, . . .	1,508,400,000	50,300,000	39,400,000	77,500,000	14.79	71,700,000
December, . . .	1,925,000,000	62,100,000	43,300,000	105,600,000	15.08	70,300,000
Total, . . .	21,318,600,000	-	-	-	-	-
Average, . . .	-	58,392,000	42,300,000	90,400,000	15.00	74,725,000

*Average Cost per Million Foot-gallons for Pumping at the East Boston Station.*Volume (21,316.6 Million Gallons) \times Lift (15.00 Feet) = 319,749.0 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot- gallons.
Labor,	\$19,798.45	.06192
Coal,	11,083.90	.03466
Oil,	359.66	.00112
Waste,	97.02	.00030
Water,	1,843.20	.00576
Packing,	51.93	.00016
Miscellaneous supplies and renewals,	1,001.80	.00313
Totals,	\$34,236.05	.10705
Labor at screens,	\$1,368.75	-

Charlestown Pumping Station.

At this station are three submerged centrifugal pumps, two of them having impeller wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 60,000,000 gallons with 8-foot lift.

Contract capacity of 2 pumps: 22,000,000 gallons each, with 11-foot lift.

Average duty for the year: 52,958,000 foot-pounds.

Average quantity raised each day: 33,500,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.

Coal used: New River and Sterling Elmora, costing from \$4.03 to \$4.53 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1915.						
January, . . .	1,150,000,000	37,400,000	18,800,000	69,100,000	9.63	54,200,000
February, . . .	1,149,300,000	41,000,000	30,500,000	60,400,000	8.57	52,500,000
March, . . .	882,700,000	28,800,000	22,100,000	35,400,000	8.40	49,800,000
April, . . .	853,400,000	28,400,000	21,100,000	45,500,000	8.14	46,600,000
May, . . .	969,700,000	31,300,000	22,400,000	44,600,000	8.15	50,400,000
June, . . .	902,100,000	30,100,000	24,400,000	40,400,000	8.41	55,300,000
July, . . .	1,267,000,000	40,900,000	25,900,000	69,300,000	8.30	56,200,000
August, . . .	1,236,900,000	39,900,000	24,900,000	61,400,000	8.49	59,300,000
September, . . .	917,200,000	30,600,000	21,800,000	41,200,000	9.07	64,700,000
October, . . .	897,900,000	29,000,000	23,100,000	45,500,000	8.36	45,500,000
November, . . .	908,000,000	30,300,000	22,700,000	50,600,000	8.43	50,400,000
December, . . .	1,064,500,000	34,300,000	23,300,000	59,600,000	8.45	50,600,000
Total, . . .	12,208,700,000	-	-	-	-	-
Average, . . .	-	33,500,000	23,400,000	51,917,000	8.53	52,958,000

Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.

Volume (12,208.7 Million Gallons) \times Lift (8.53 Feet) = 104,140.2 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot- gallons.
Labor,	\$12,589 80	\$0.12089
Coal,	4,297 81	.04127
Oil,	93 36	.00090
Waste,	71 17	.00068
Water,	522 00	.00501
Packing,	52 90	.00051
Miscellaneous supplies and renewals,	458 74	.00441
Totals,	\$18,085 78	\$0.17367
Labor at screens,	\$3,138 08	-

Alewife Brook Pumping Station.

The plant at this station consists of two 9-inch Andrews commercial centrifugal pumps, direct connected by horizontal shafts to compound marine engines, together with a pump and engine added later. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the two original pumps: 4,500,000 gallons each, with 13-foot lift.

Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.

Average duty for the year: 17,333,000 foot-pounds.

Average quantity raised each day: 3,371,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: New River, costing from \$4.89 to \$5.16 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.

MONTES.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1915.						
January,	123,539,000	3,985,000	2,036,000	8,406,000	12.96	17,100,000
February,	140,947,000	5,034,000	3,380,000	7,934,000	12.97	19,100,000
March,	102,312,000	3,300,000	2,550,000	4,493,000	13.00	18,400,000
April,	83,484,000	2,783,000	2,503,000	3,862,000	13.08	16,000,000
May,	85,094,000	2,745,000	2,078,000	3,968,000	13.06	17,000,000
June,	69,966,000	2,332,000	2,036,000	3,574,000	13.04	16,200,000
July,	146,803,000	4,736,000	2,928,000	7,875,000	12.88	22,500,000
August,	148,616,000	4,794,000	3,129,000	7,934,000	12.68	21,500,000
September,	76,584,000	2,553,000	2,162,000	3,229,000	12.89	14,700,000
October,	74,890,000	2,416,000	1,994,000	3,814,000	12.96	14,300,000
November,	74,272,000	2,476,000	2,078,000	4,143,000	13.01	14,900,000
December,	102,355,000	3,302,000	2,246,000	5,688,000	12.97	16,300,000
Total,	1,228,862,000	-	-	-	-	-
Average,	-	3,371,000	2,427,000	5,410,000	12.97	17,333,000

*Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.*Volume (1,228.862 Million Gallons) \times Lift (12.97 Feet) = 15,938.34 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$6,388 19	\$0.40081
Coal,	1,869 45	.11729
Oil,	127 46	.00800
Waste,	93 74	.00588
Water,	191 40	.01201
Packing,	34 72	.00218
Miscellaneous supplies and renewals,	180 87	.01135
Totals,	\$8,885 83	\$0.55752
Labor at screens, oiling and miscellaneous services,	\$2,170 15	-

SOUTH METROPOLITAN SYSTEM.

Ward Street Pumping Station.

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of 2 pumps: 50,000,000 gallons each, with 45-foot lift.

Average duty for the year: 82,029,000 foot-pounds.

Average quantity raised each day: 26,933,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 5 oilers, 4 assistant engineers, 1 machinist and 1 laborer.

Coal used: Sterling Elmora and New River, costing from \$4.72 to \$5.01 per gross ton.

Material intercepted at screens during the year, 1,300.4 cubic yards.

Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1915.						
January, . . .	983,508,000	31,791,000	19,778,000	58,290,000	41.69	89,590,000-
February, . . .	945,322,000	33,762,000	25,868,000	47,847,000	42.30	83,700,000
March, . . .	797,149,000	25,714,000	21,262,000	33,254,000	42.00	78,582,000
April, . . .	774,216,000	25,807,000	22,065,000	32,092,000	41.89	76,000,000
May, . . .	706,008,000	22,774,000	18,420,000	29,680,000	41.42	69,455,000
June, . . .	615,943,000	20,531,000	17,546,000	27,145,000	41.10	74,879,000
July, . . .	988,594,000	31,890,000	22,447,000	59,983,000	41.75	93,752,000
August, . . .	1,011,250,000	32,622,000	22,948,000	45,003,000	42.05	94,886,000
September, . . .	786,581,000	26,219,000	21,395,000	30,125,000	41.39	86,222,000
October, . . .	732,954,000	23,644,000	19,814,000	34,895,000	41.35	78,843,000
November, . . .	642,621,000	21,421,000	18,397,000	30,888,000	41.67	68,271,000
December, . . .	837,686,000	27,022,000	18,712,000	44,295,000	41.78	90,168,000
Total, . . .	9,821,832,000	-	-	-	-	-
Average, . . .	-	26,933,000	20,679,000	39,458,000	41.70	82,029,000

Records from plunger displacement.

Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.

Volume (9,821.8 Million Gallons) \times Lift (41.7 Feet) = 409,569.06 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$17,417 22	\$0.04253
Coal,	10,711 40	0.02615
Oil,	189 56	0.00046
Waste,	23 25	0.00006
Water,	1,470 00	0.00359
Packing,	98 59	0.00024
Miscellaneous supplies and renewals,	3,705 26	0.00905
Totals,	\$33,615 28	\$0.08208
Labor at screens,	\$4,353 47	-

Quincy Pumping Station.

At this station are two compound condensing Deane pumping engines and one Lawrence centrifugal pump driven by a Sturtevant compound condensing engine.

Contract capacity of 3 pumps: Deane, 3,000,000 gallons; Deane, 5,000,000 gallons; Lawrence centrifugal, 10,000,000 gallons.

Average duty for the year: 30,280,000 foot-pounds.

Average quantity raised each day: 3,865,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: New River, costing from \$4.51 to \$4.99 per gross ton.

Materials intercepted at screen during the year, 235 cubic yards.

Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1915.						
January,	163,000,000	5,258,000	3,082,000	7,469,000	23.71	31,000,000
February,	174,018,000	6,215,000	5,277,000	7,835,000	26.18	31,800,000
March,	140,411,000	4,529,000	3,739,000	5,722,000	21.88	30,300,000
April,	111,527,000	3,718,000	2,584,000	4,174,000	20.94	31,100,000
May,	105,420,000	3,401,000	2,907,000	3,843,000	21.01	33,500,000
June,	87,725,000	2,924,000	2,571,000	3,189,000	21.07	30,100,000
July,	118,465,000	3,821,000	3,304,000	4,940,000	21.25	32,400,000
August,	124,317,000	4,010,000	3,273,000	4,813,000	20.87	32,200,000
September,	106,318,000	3,544,000	2,842,000	5,150,000	20.65	30,600,000
October,	90,728,000	2,927,000	2,498,000	3,190,000	20.99	27,800,000
November,	82,173,000	2,739,000	2,111,000	2,975,000	20.95	25,800,000
December,	102,114,000	3,294,000	2,541,000	4,111,000	20.85	26,800,000
Total,	1,406,225,000	-	-	-	-	-
Average,	-	3,865,000	3,061,000	4,768,000	21.70	30,280,000

*Average Cost per Million Foot-gallons for Pumping at the Quincy Station.*Volume (1,406.2 Million Gallons) \times Lift (21.7 Feet) = 30,514.54 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$6,628 37	\$0.21722
Coal,	1,854 65	.06077
Oil,	31 08	.00102
Waste,	26 38	.00086
Water,	203 56	.00667
Packing,	45 98	.00151
Miscellaneous supplies and renewals,	418 26	.01276
Totals,	\$9,208 28	\$0.30181
Labor at screen, oiling and miscellaneous services,	\$1,782 91	-

Nut Island Screen-house.

The plant at this house includes two sets of screens in duplicate actuated by small reversing engines of the Fitchburg type. Two vertical Deane boilers, 80 horse-power each, operate the engines, provide heat and light for the house, burn materials intercepted at the screens, and furnish power for the Quincy (Hough's Neck) sewage lifting station.

Average daily quantity of sewage passing screens, 52,300,000 gallons.

Total materials intercepted at screens, 1,129.3 cubic yards.

Materials intercepted per million gallons of sewage discharged, 1.59 cubic feet.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: Sterling Elmora and New River, costing from \$4.14 to \$4.75 per gross ton.

Quincy (Hough's Neck) Sewage Lifting Station.

At this station are two 6-inch submerged Lawrence centrifugal pumps with vertical shafts actuated by two Sturtevant direct-current motors.

The labor and electric energy for this station are supplied from the Nut Island screen-house and as used at present it does not materially increase the amount of coal used at the latter station. The effluent is largely ground water.

Contract capacity of 2 pumps: about 1,500,000 gallons each, with 20-foot lift.

Average daily amount pumped, 177,700 gallons.

Average lift, 16.1 feet.

Coal delivered in the Bins of the Sewerage Works Pumping Stations during the Year.

	GROSS TONS, BITUMINOUS COAL.							Price per Gross Ton. ¹
	Dear Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alerie Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screen-house.	
Gorman-Leonard Coal Company,	317	-	-	-	-	-	-	\$3 77
Gorman-Leonard Coal Company,	1,115	-	-	-	-	-	-	3 82
New England Coal & Coke Company.	707	-	-	-	-	-	-	4 17
New England Coal & Coke Company.	746	-	-	-	-	-	-	4 22
Gorman-Leonard Coal Company,	-	395	-	-	-	-	-	3 77
Gorman-Leonard Coal Company,	-	407	-	-	-	-	-	3 89
Gorman-Leonard Coal Company,	-	331	-	-	-	-	-	3 90
Gorman-Leonard Coal Company,	-	369	-	-	-	-	-	4 03
New England Coal & Coke Company.	-	355	-	-	-	-	-	4 17
New England Coal & Coke Company.	-	736	-	-	-	-	-	4 21
Gorman-Leonard Coal Company,	-	-	285	-	-	-	-	4 03
Gorman-Leonard Coal Company,	-	-	233	-	-	-	-	4 04
Gorman-Leonard Coal Company,	-	-	159	-	-	-	-	4 24
Metropolitan Coal Company,	-	-	250	-	-	-	-	4 49
Metropolitan Coal Company,	-	-	290	-	-	-	-	4 53
Locke Coal Company,	-	-	-	65	-	-	-	4 89
Locke Coal Company,	-	-	-	12	-	-	-	5 07
Locke Coal Company,	-	-	-	49	-	-	-	5 16
Locke Coal Company,	-	-	-	246	-	-	-	5 15
Gorman-Leonard Coal Company,	-	-	-	-	192	-	-	4 72
Gorman-Leonard Coal Company,	-	-	-	-	327	-	-	4 73
Gorman-Leonard Coal Company,	-	-	-	-	115	-	-	4 77
Gorman-Leonard Coal Company,	-	-	-	-	36	-	-	4 81
Gorman-Leonard Coal Company,	-	-	-	-	129	-	-	4 82
Gorman-Leonard Coal Company,	-	-	-	-	222	-	-	4 87
Gorman-Leonard Coal Company,	-	-	-	-	468	-	-	4 88
Staples Coal Company,	-	-	-	-	20	-	-	4 93
Staples Coal Company,	-	-	-	-	28	-	-	4 95
Staples Coal Company,	-	-	-	-	375	-	-	4 96
Staples Coal Company,	-	-	-	-	126	-	-	4 99
Staples Coal Company,	-	-	-	-	176	-	-	5 01

¹ Includes adjustments for quality.

*Coal delivered in the Bins of the Sewerage Works Pumping Stations during the Year
— Concluded.*

	GROSS TONS, BITUMINOUS COAL.							Price per Gross Ton. ¹
	Deer Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alerville Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screen House.	
Frost Coal Company, . . .	-	-	-	-	-	-	55	\$4 51
Frost Coal Company, . . .	-	-	-	-	-	-	153	4 69
Frost Coal Company, . . .	-	-	-	-	-	-	73	4 73
Frost Coal Company, . . .	-	-	-	-	-	-	65	4 76
Frost Coal Company, . . .	-	-	-	-	-	-	42	4 99
Gorman-Leonard Coal Company,	-	-	-	-	-	-	222	4 14
Gorman-Leonard Coal Company,	-	-	-	-	-	-	175	4 18
Metropolitan Coal Company, .	-	-	-	-	-	-	228	4 75
Total gross tons, . . .	2,885	2,593	1,217	372	2,224	388	625	-
Average price per gross ton, .	\$4 00	\$4 02	\$4 27	\$5 08	\$4 89	\$4 72	\$4 37	-

¹ Includes adjustments for quality.

METROPOLITAN SEWERAGE OUTFALLS.

The Deer Island outfall has been in continuous operation since May, 1895. It is in good condition.

The 60-inch outfalls of the South Metropolitan System, completed in October, 1904, were examined by a diver during the year and were found to be in good condition and free from deposit.

During the year the average flow through the North Metropolitan outfall at Deer Island has been 60,392,000 gallons of sewage per 24 hours, with a maximum rate of 151,600,000 gallons during the stormy period in August, 1915. The amount of sewage discharged in the North Metropolitan District averaged 111 gallons per day for each person, taking the estimated population of the district contributing sewage. If the sewers in this district were restricted to the admission of sewage proper only, this per capita amount would be considerably decreased.

In the South Metropolitan District an average of 52,300,000 gallons of sewage has passed daily through the screens at the Nut Island

screen-house, and has been discharged from the outfalls into the outer harbor. The maximum rate of discharge per day, which occurred during a heavy storm on July 1, 1915, was 155,000,000 gallons. The discharge of sewage through these outfalls represents the amount of sewage contributed in the South Metropolitan System, which was at the rate of 174 gallons per day per person of the estimated number contributing sewage in the district.

The daily discharge of sewage per capita is considerably larger in the South Metropolitan District than it is in the North Metropolitan District, because, owing to the large size of the High-level sewer, more storm water is at present admitted to the sewers.

Material Intercepted at the Screens.

The material intercepted at the screens at the North Metropolitan Sewerage stations, consisting of rags, paper and other floating materials, has during the year amounted to 2,193.4 cubic yards. This is equivalent to 2.691 cubic feet for each million gallons of sewage pumped at Deer Island.

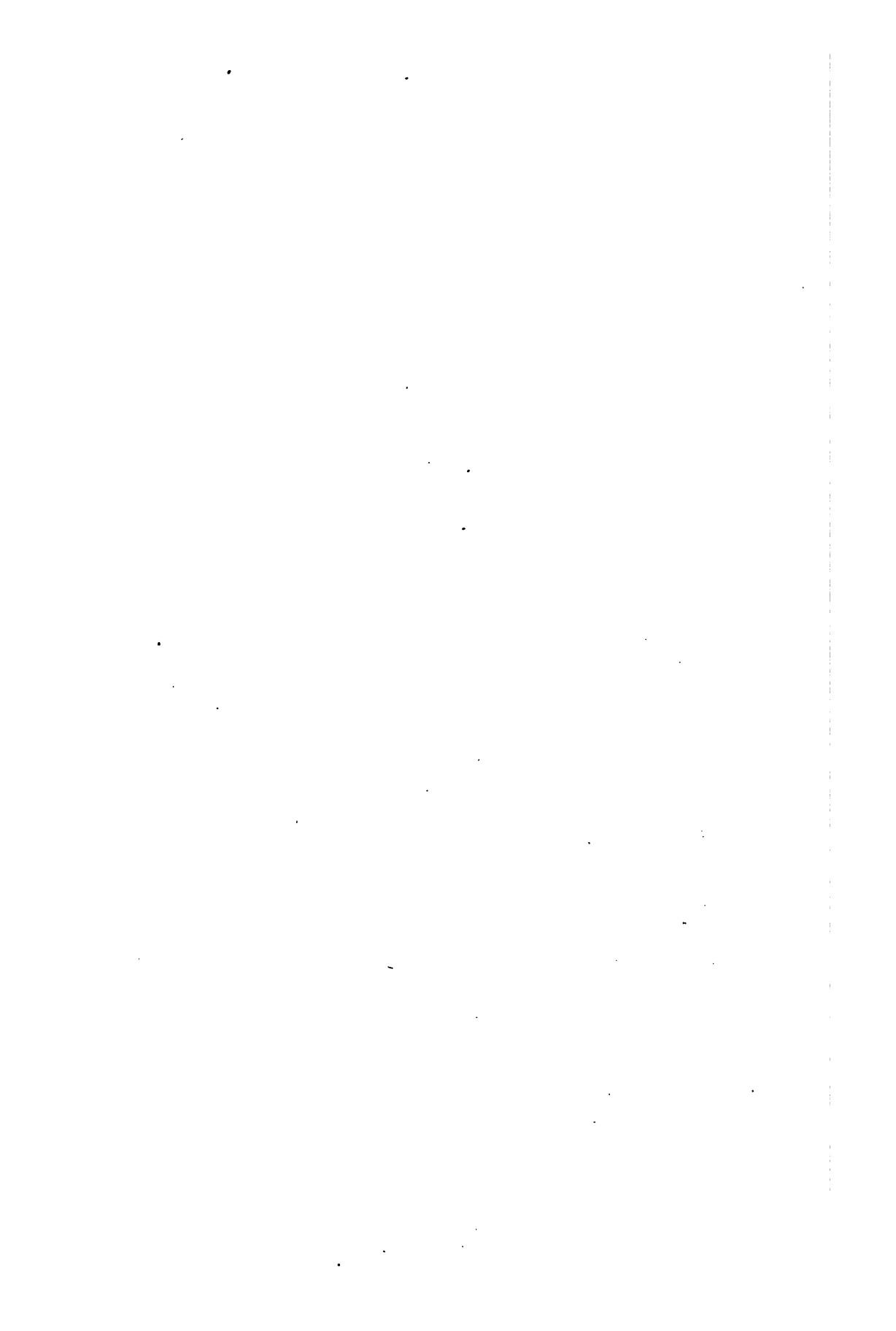
The material intercepted at the screens at the South Metropolitan Sewerage stations has amounted to 2,664.7 cubic yards, equal to 3.77 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers and siphons indicate that they are free from deposit.

Respectfully submitted,

FREDERICK D. SMITH,
Engineer of Sewerage Works.

BOSTON, January 1, 1916.



APPENDIX.

APPENDIX No. 1.

CONTRACTS MADE AND PENDING DURING

(NOTE. — The details of contracts made before

1. Number of Contract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Lowest.	5. Lowest.	
1 354 ¹	Constructing water pipe tunnel under Chelsea Creek, between East Boston and Chelsea.	4	\$62,695 00	\$60,300 00 ²	Coleman Bros., Chelsea, Mass.
2 357 ¹	Steel tank or reservoir on Bellevue Hill, Boston.	5	19,540 00	19,397 00 ²	Walsh's Holyoke Steam Boiler Works, Holyoke, Mass.
3 359 ¹	Laying 24-inch water pipes in Boston, Milton and Quincy.	15	16,225 00	15,208 20 ²	John J. Evans, Lawrence, Mass.
4 362 ¹	3,930 tons 60-inch cast iron water pipe; 120 tons special castings.	4	87,547 50	82,908 00 ²	United States Cast Iron Pipe & Foundry Co., Philadelphia, Penn.
5 363 ¹	2,800 tons 60-inch cast iron water pipe; 100 tons special castings.	- ³	- ³	- ³	United States Cast Iron Pipe & Foundry Co., Philadelphia, Penn.
6 364	Furnishing and installing hydraulic machinery at Sudbury Dam, Southborough.	3	13,737 00	11,760 00 ²	S. Morgan Smith Co., York, Penn.
7 364-A	Furnishing and installing electric machinery at Sudbury Dam, Southborough.	3	22,112 00	19,349 00 ²	Westinghouse Electric & Mfg. Co., Pittsburgh, Penn.
8 365 ¹	90 tons 4-inch to 48-inch special castings.	4	4,410 00	4,265 00 ²	Standard Cast Iron Pipe & Foundry Co., Bristol, Penn.
9 366 ¹	Furnishing and laying 24-inch and 60-inch steel pipe, Boston, Milton and Newton.	3	3,460 00	3,320 00 ²	Walsh's Holyoke Steam Boiler Works, Holyoke, Mass.
10 367 ¹	Water valves; 9 12-inch, 4 16-inch, 4 20-inch and 3 24-inch screw lift valves.	3	3,305 00	3,225 00 ²	Pratt & Cady Co., Inc., Boston, Mass.
11 368	Masonry tower on Bellevue Hill, Boston.	11	46,900 00	46,000 00 ²	John Cashman & Sons Co., Boston.

¹ Contract completed.² Contract based upon this bid.³ Contractor for No. 362 agreed to accept prices bid under that contract for additional quantities included in No. 363.

APPENDIX NO. 1.

THE YEAR 1915 — WATER WORKS.

1915 have been given in previous reports.]

7. Date of Contract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1915.
Apr. 27, 1914	Feb. 20, 1915	See previous report,	\$63,405 01 1
Aug. 7, 1914	June 12, 1915	For whole work, \$19,397,	19,795 14 2
Aug. 4, 1914	Aug. 7, 1915	See previous report,	20,795 62 3
Nov. 25, 1914	July 20, 1915	For pipes, \$19.60 per ton of 2,000 pounds; for special castings, \$49 per ton of 2,000 pounds.	78,838 14 4
Nov. 28, 1914	Sept. 20, 1915	For pipes, \$19.60 per ton of 2,000 pounds; for special castings, \$49 per ton of 2,000 pounds.	68,271 50 ⁴ 5
June 23, 1915	-	For furnishing and installing hydraulic machinery at the Sudbury Dam, in Southborough, \$11,760.	10,000 00 6
June 23, 1915	-	For furnishing and installing electric machinery at the Sudbury Dam, in Southborough, \$19,349.	15,000 00 7
Feb. 13, 1915	July 20, 1915	For special castings, \$48.50 per ton of 2,000 pounds, .	4,534 07 8
Feb. 23, 1915	Sept. 1, 1915	For furnishing and laying 76.58 lin. ft. of 24-inch steel pipe in two lines over N. Y., N. H. & H. R.R., \$750; furnishing and laying 134 lin. ft. of 24-inch steel pipe in one line over Neponset River, \$850; furnishing and laying 85.8 lin. ft. 60-inch steel pipe in one line under Boston & Albany R.R., \$1,720.	3,320 00 9
Feb. 15, 1915	Aug. 16, 1915	For 12-inch screw lift valves, \$110 each; for 16-inch screw lift valves, \$140 each; for 20-inch screw lift valves, \$206 each; for 24-inch screw lift valves, \$285 each.	3,225 00 10
Apr. 23, 1915	-	For tower complete with all appurtenances, \$46,000..	41,000 00 11

⁴ Does not include \$2,369.46 for pipes for Metropolitan Sewerage Works.

CONTRACTS MADE AND PENDING DURING

1. Number of Contract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Lowest.	5. Lowest.	
12 369	Laying 60-inch water pipes in Newton.	11	\$32,615 00	\$32,369 00 ¹	Andrew M. Cusack, Boston.
13 370 ¹	Laying 60-inch water pipes in Newton.	10	27,282 80	27,177 50 ¹	Charles A. Kelley, Somerville, Mass.
14 371 ¹	27,595 lbs. 24-inch to 66-inch special castings.	5	1,007 22 ²	950 00	United States Cast Iron Pipe & Foundry Co., Philadelphia, Penn.
15 372 ¹	Hand traveling crane for Sudbury Dam, Southborough.	8	965 00	880 00 ²	Worham, Sanger & Bates, Inc., Boston.
16 373	Underground cable for hydro-electric plant at Sudbury Dam.	1 ³	-	1,182 61 ²	Safety Insulated Wire & Cable Co., Boston.
17 35-M ¹	400 tons C. C. B. New River coal for Arlington pumping station.	2	\$4.28 ² per ton.	\$4.20 per ton.	Bader Coal Co., Boston.
18 36-M ¹	700 tons C. C. B. New River coal for Spot Pond pumping station.	2	\$5.30 per ton.	\$5.10 ² per ton.	Bader Coal Co., Boston.
19 37-M ¹	4,000 tons Beaver Run coal for Chestnut Hill pumping stations, and 260 tons Sterling coal for Hyde Park pumping station.	Chest- nut Hill sta- tions, 5. Hyde Park sta- tion, 3.	- ⁴	- ⁴	Gorman-Leonard Coal Co., Worcester.
20 39-M	Sale and purchase of electric energy to be developed at the Sudbury Dam.	2	- ⁷	- ⁷	Edison Electric Illuminating Co., Boston.
21 40-M	800 tons C. C. B. New River coal for Spot Pond pumping station.	2	\$5.25 per ton.	\$5.10 ² per ton.	Bader Coal Co., Boston.

¹ Contract completed.² Contract based upon this bid.³ Two other proposals received which did not conform to requirements of specifications.

THE YEAR 1915 — WATER WORKS — *Continued.*

7. Date of Contract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1915.
Apr. 30, 1915	-	For laying 60-inch cast iron pipe, \$3.74 per lin. ft.; for laying 12-inch cast iron pipe for blow-offs, \$1 per lin. ft.; for rock excavation above regular grade of the bottom of the trench, \$7.40 per cu. yd.; for rock excavation below regular grade of the bottom of the trench, \$7.40 per cu. yd.; for earth excavation below regular grade of bottom of trench, \$1.50 per cu. yd.; for chambers for air valves, \$49 each; for chambers for blow-off and by-pass valves, \$55 each; for chamber for 36-inch valve, \$55; for concrete masonry, \$6.75 per cu. yd.	\$47,900.00 12
May 18, 1915	Dec. 11, 1915	For laying 60-inch cast iron pipe, \$3.75 per lin. ft.; for laying 12-inch and 16-inch cast iron pipe for blow-offs, \$1.50 per lin. ft.; for rock excavation above the regular grade of the bottom of the trench, \$5 per cu. yd.; for rock excavation below the regular grade of the bottom of the trench, \$5 per cu. yd.; for earth excavation below the regular grade of the bottom of the trench, \$1 per cu. yd.; for chambers for valves, \$60 each; for concrete masonry, \$10 per cu. yd.	33,349.56 13
June 4, 1915	July 20, 1915	For special castings, \$73 per ton of 2,000 pounds.	1,082.55 14
Aug. 9, 1915	Oct. 26, 1915	For furnishing and installing a 6-ton hand traveling crane, \$880.	880.00 15
Dec. 2, 1915	-	For furnishing and installing about 1,550 feet of 15,000-volt, 3-conductor cable, \$1,182.81.	500.00 16
June 25, 1914	Apr. 21, 1915	\$4.28 per ton of 2,240 pounds delivered on cars at the Arlington station.	1,705.54 17
June 25, 1914	Apr. 10, 1915	\$5.10 per ton of 2,240 pounds delivered in bins at the Spot Pond station.	3,842.61 18
June 25, 1914	May 21, 1915	\$4.02 per ton of 2,240 pounds delivered on cars at the Chestnut Hill stations; \$4.10 per ton of 2,240 pounds delivered on cars at the Hyde Park station.	17,027.87 19
Dec. 21, 1914	-	\$6.25 per thousand kilowatt hours. Estimated amount of electric energy available per year, 3,000,000 kilowatt hours.	- 20
June 15, 1915	-	\$5.10 per ton of 2,240 pounds delivered in bins at the Spot Pond station.	2,758.65 21

* For Sonman coal, \$3.89, for Sterling coal, \$3.94 and for Beaver Run, Riverside or Davenport coal, \$4.02 per ton.

¹ Contract based upon bid of \$6.25 per M. kilowatt hours for entire output. Bid of \$5.50 per M. kilowatt hours for at least one-third of output and of \$3 per M. kilowatt hours for at least two-thirds of output also received.

CONTRACTS MADE AND PENDING DURING

1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Lowest.	5. Lowest.	
22 41-M	5,000 tons Alpha Special coal for Chestnut Hill pumping stations, and 80 tons Alpha Special coal for Pegan pumping station, Natick.	Chestnut Hill stations, 6. Pegan station, 4.	-*	-*	H. N. Hartwell & Son, Boston.
23 42-M	150 tons Ralphton Mine coal for Hyde Park pumping station.	6	\$4.10 per ton.	\$4.05 per ton.	Quemahoning Coal Co., Boston.
24 43-M	450 tons Brasil Smokeless coal for Arlington pumping station.	4	\$4.30 per ton.	\$4.25 per ton.	Hetherington & Co., Philadelphia, Penn.
25 44-M ¹	Surface water drains at Spot Pond.	14	3,223 50	3,208 10 ¹	Thomas Russo & Co., Boston.
26 45-M	Electrically operated sluice gates for Sudbury power plant.	3	4,125 00	3,915 00 ¹	Coffin Valve Co., Boston.
27 Special ¹ Order.	3 tons 4-inch cast iron pipe, 30 tons 12-inch pipe.	4	727 06	701 40 ¹	Warren Foundry & Machine Co., Phillipsburg, N. J.
28 Special ¹ Order.	10 sets steelwork for chambers for 36-inch valves.	5	390 00	360 00 ¹	F. A. Houdlette & Son, Boston.
29 Agree- ment.	3 horizontal type hydraulic governors.	-*	-*	-*	Lombard Governor Co., Ashland, Mass.

* For Sterling Elmora or Riverside coal, \$3.97, for Davenport coal, \$3.98 and for Alpha Special coal, \$4 per ton.

¹ Contract based upon this bid.

THE YEAR 1915 — WATER WORKS — *Continued.*

7. Date of Contract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1915.
June 15, 1915	-	\$4 per ton of 2,240 pounds delivered on cars at the Chestnut Hill stations; \$4.25 per ton of 2,240 pounds delivered on cars at the Natick Station on the Boston & Albany Railroad.	\$10,642 22 22
June 15, 1915	-	\$4.05 per ton of 2,240 pounds delivered on cars at the Hyde Park pumping station.	552 43 23
June 15, 1915	-	\$4.30 per ton of 2,240 pounds delivered on cars at the Arlington pumping station.	857 97 24
Oct. 2, 1915	Nov. 27, 1915	For furnishing and laying 15-inch vitrified clay pipe, \$0.98 per lin. ft.; for furnishing and laying 12-inch vitrified clay pipe, \$0.77 per lin. ft.; for constructing paved open channel, \$0.80 per lin. ft.; for rock excavation, \$4 per cu. yd.; for manholes, \$20 each; for catch basins, — Type A, \$42 each; Type B, \$25 each.	3,683 22 25
Oct. 7, 1915	-	For furnishing and installing three electrically operated sluice gates, \$3,915.	1,000 00 26
Feb. 13, 1915	Feb. 22, 1915	For 4-inch pipe, \$23.80 per ton of 2,000 pounds; for 12-inch pipe, \$21 per ton of 2,000 pounds.	732 41 27
Jan. 27, 1915	Mar. 13, 1915	For each set, \$36,	360 00 28
July 21, 1915	-	For whole work, \$2,404,	2,404 00 29
			\$457,263 51

¹ Contract completed.² Competitive bids were not received.

CONTRACTS MADE AND PENDING DURING THE YEAR 1915 — WATER WORKS —
Concluded.

Summary of Contracts, 1895 to 1915, inclusive.¹

	Value of Work done Dec. 31, 1915.
Distribution Department, 11 contracts,	\$384,434 04
Sudbury Department, 5 contracts,	27,462 55
353 contracts completed from 1896 to 1914, inclusive,	16,948,532 40
	\$17,360,418 99
Deduct for work done on 11 Sudbury Reservoir contracts by the city of Boston,	512,000 00
Total of 380 contracts,	\$16,848,418 99

¹ In this summary contracts charged to maintenance are excluded.

APPENDIX No. 2.

Summary of Tests of Cements used in the Construction of the Wachusett Dam and Other Works at the Wachusett Reservoir, 1901 to 1907, inclusive.

BRAND.	NUMBER OF BARRELS USED.	At Dam.	TOTALS.	COMPOSITION OF BRIDGULETTE.		FINENESS.	WIRE TESTS.	TENSILE STRAIGHT.		
				NUMBER OF BRIDGULETTES.	SQUARE INCH.			NUMBER OF BRIDGULETTES.	SQUARE INCH.	NUMBER OF BRIDGULETTES.
Portland cement:—										
1 Alpha, .	150	491	Neat, .4	10.9	28.6	168	347	47	694	47
2 Alben, .	225	335	2 to 1, Neat, .4	11.2	26.4	116	316	—	316	47
3 Atlas, .	3,094	3,793	2 to 1, Neat, .2	9.0	22.4	113	354	207	571	207
4 Cecakill, .	—	—	2 to 1, Neat, .4	7.0	22.3	130	450	—	450	—
5 Giant, .	65,809	70,786	2 to 1, Neat, .5	8.7	21.9	141	380	4,097	636	298
6 Heiderberg, .	200	212	2 to 1, Neat, .2	5.0	19.9	173	450	—	383	23
7 Iron Clad, .	4,260	4,540	2 to 1, Neat, .1	4.2	17.1	86	304	222	632	218
8 Lehigh, .	8,074	14,926	2 to 1, Neat, .1	8.2	22.0	220	484	983	626	484
9 Star, .	—	—	2 to 1, Neat, .5	9.8	24.4	147	335	51	601	154
10 Stettin-Girstow, .	—	2,200	2 to 1, Neat, .7	8.3	21.3	62	178	252	377	261
11 Whitehall, .	150	160	2 to 1, Neat, .3	8.3	27.5	180	360	30	736	20
Total, .	81,962	98,981	{ Neat, .4 2 to 1,	8.4	21.8	144	281	5,943	570	5,875
Natural cement:—			{ Neat, .9 1 to 1, (2 to 1,	—	—	—	385	—	5,942	394
12 Union, .	182,480	182,480	{ Neat, .6 1 to 1, (2 to 1,	6.2	13.6	66	131	7,070	173	7,042

Summary of Tests of Cements used in the Construction of the Wachusett Dam and Other Works at the Wachusett Reservoir, 1891 to 1907, inclusive—Concluded.

APPENDIX NO. 3.

No. 57.]

AND SEWERAGE BOARD.

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TABLE No. 1.—*Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1915.*

PLACE.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Princeton,	5.63	2.51	0.07	1.93	1.01	2.73	8.75	7.25	1.79	2.95	3.30	4.31	42.86
Jefferson,	7.83	3.88	0.08	2.09	1.94	3.50	7.92	7.21	1.50	3.20	3.39	6.69	49.03
Sterling,	5.48	3.29	0.05	1.70	1.65	2.78	8.87	6.14	1.74	2.91	2.97	6.05	42.33
Boylston,	6.31	3.88	0.04	1.47	1.59	3.69	9.18	7.00	1.10	3.12	2.81	4.48	44.37
Sudbury Dam,	6.08	3.40	0.03	2.54	1.48	3.39	8.86	6.22	0.87	3.06	2.76	4.85	43.53
Framingham,	6.49	3.37	0.04	2.46	1.63	3.47	7.92	5.80	1.03	2.99	2.61	5.33	43.04
Ashland Dam,	6.63	3.44	0.06	2.42	1.94	3.66	7.51	5.40	1.29	2.74	2.65	4.07	42.41
Cordaville,	6.83	4.12	0.07	2.51	1.92	4.09	8.21	6.06	1.19	3.00	3.22	5.63	46.76
Lake Cochituate,	6.57	3.88	0.01	2.82	1.59	3.51	8.38	5.72	0.88	2.93	2.68	5.48	44.35
Chestnut Hill Reservoir,	6.89	3.44	0.00	2.92	1.48	5.42	6.75	6.39	1.02	2.90	2.38	5.33	44.92
Spot Pond,	6.42	3.49	0.04	3.33	1.54	5.24	8.48	8.39	.84	3.06	2.46	5.30	48.51
Average of all,	6.47	3.49	0.04	2.38	1.66	3.77	8.33	6.50	1.21	2.99	2.82	5.18	44.74
Average, Wachusett watershed,	6.31	3.32	0.06	1.80	1.07	3.18	8.60	6.90	1.63	3.05	3.12	5.11	44.65
Average, Sudbury watershed,	6.61	3.88	0.05	2.48	1.74	3.65	8.12	5.87	1.10	2.95	2.70	5.09	43.98

TABLE No. 2.—Rainfall in Inches at Jefferson, Mass., in 1915.

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	2	-	-	-	-	2	0.70	-	-	-	-
2,	0.06 ¹	2	-	-	-	-	2.70	0.45	-	0.74	0.09	0.07 ¹
3,	-	1.22 ²	-	1.26 ¹	0.12	-	2	2	-	-	-	-
4,	-	-	-	-	-	-	0.34	3.64	-	-	2	-
5,	-	-	-	-	0.17	-	0.28	-	-	0.59	0.27	-
6,	2	0.89	-	0.21	-	0.23	-	0.34	-	-	-	-
7,	0.84	2	-	-	2	0.12	-	-	-	2	-	-
8,	-	0.14 ¹	-	-	0.54	-	2.26	-	-	0.78	-	0.04 ¹
9,	-	-	-	-	-	-	0.16	0.07	-	-	-	-
10,	-	-	-	-	-	-	-	-	-	-	-	-
11,	-	-	-	0.27	-	-	2	-	-	-	-	-
12,	2	-	-	-	-	-	0.24	-	-	-	-	-
13,	2.20 ²	-	-	-	0.19	-	-	0.72	0.07	-	-	2
14,	-	-	-	-	-	-	-	-	0.23	-	2	2.22 ¹
15,	-	2	-	-	-	0.19	-	-	-	0.29	0.08	-
16,	-	0.60	-	-	-	-	-	-	-	-	-	-
17,	2	-	-	-	0.20	0.27	0.06	-	-	-	-	2
18,	1.45	-	-	-	-	-	-	-	-	-	-	1.98
19,	0.21	-	-	-	-	0.30	0.49	-	-	-	1.51	-
20,	-	-	-	-	-	0.28	-	-	-	0.53	-	-
21,	-	-	-	-	2	-	0.16	-	1.00	-	-	-
22,	-	-	0.08 ¹	-	0.42	-	0.20	0.84	-	-	-	-
23,	1.39 ²	-	-	-	-	-	-	-	-	2	0.23	-
24,	-	2	-	-	-	-	-	-	-	-	0.19 ²	-
25,	1.11 ²	1.49	-	-	-	-	0.22	0.20	-	-	-	2
26,	-	0.04 ¹	-	-	0.20	0.46	-	-	0.20	0.27	-	1.10 ²
27,	-	-	-	-	-	0.35	-	-	-	-	-	-
28,	0.07 ¹	-	-	-	-	-	2	-	-	-	-	0.26 ²
29,	-	-	-	0.35	-	0.10	-	0.74	2	-	0.35	0.69 ²
30,	-	-	-	-	-	1.20	0.07	-	-	-	-	-
31,	0.50 ²	-	-	-	-	-	-	-	-	-	-	-
Totals,	7.88	3.88	0.08	2.00	1.84	3.50	7.92	7.21	1.50	3.20	3.39	6.59

Total for the year 49.03 inches.

¹ Snow.² Rainfall included in that of following day.³ Rain and snow.

TABLE NO. 3.—*Rainfall in Inches at Framingham, Mass., in 1915.*

DAY OF MONTH.	JANUARY.	FEBRUARY.	MARCH.	APRIL.	MAY.	JUNE.	JULY.	AUGUST.	SEPTEMBER.	OCTOBER.	NOVEMBER.	DECEMBER.
1,	-	2	-	-	-	-	2	2	-	2	-	-
2,	0.02 ¹	2	-	-	0.02	-	2	0.83	-	1.13	0.03	0.02 ¹
3,	-	1.09 ²	-	2	-	-	2.77	0.11	-	-	0.04	-
4,	-	-	-	1.10 ¹	2	-	2	2	-	-	2	-
5,	-	2	-	-	0.02	-	0.32	2	-	2	0.34	-
6,	-	0.36	-	0.13	-	2	-	2	-	0.43	-	-
7,	0.58	2	-	-	2	2	2	2.90	2	2	-	-
8,	-	0.07 ³	-	-	0.38	0.36	2.10	-	0.01	0.05	-	0.07 ¹
9,	-	-	-	-	-	-	-	0.03	-	-	-	-
10,	-	-	-	2	-	-	-	-	-	-	-	-
11,	2	-	-	2	-	0.01	2	-	-	-	-	-
12,	2	0.02	-	0.22	0.01	-	0.11	-	-	-	0.04	-
13,	2.04 ³	-	-	-	0.21	-	-	0.72	0.10	-	-	2
14,	-	2	-	-	-	-	0.96	-	-	-	2	1.63 ²
15,	0.07	2	-	-	-	2	-	-	-	0.55	0.67	-
16,	-	0.60	-	-	-	0.02	-	-	0.02	-	-	-
17,	2	-	0.01 ¹	-	0.23	0.38	0.01	-	-	-	-	2
18,	2	-	-	-	-	-	-	-	-	-	-	1.69
19,	1.55	-	-	-	-	0.11	0.59	-	0.15	-	1.08	-
20,	-	-	-	-	-	0.33	2	-	-	0.11	-	-
21,	-	-	-	-	2	-	0.12	-	0.70	-	-	-
22,	2	-	2	2	0.59	2	-	0.90	-	-	-	-
23,	0.65 ³	2	0.02 ³	0.01	-	0.15	-	-	-	-	2	0.29
24,	2	2	-	-	-	-	-	2	0.01	-	0.07 ¹	-
25,	0.93 ³	1.14	-	-	-	2	-	0.19	-	-	-	2
26,	-	-	-	-	0.17	0.08	2	-	0.04	0.10	-	0.66 ²
27,	-	-	-	-	-	-	0.21	-	-	-	-	-
28,	0.01 ¹	-	-	-	-	-	2	-	-	-	-	0.17
29,	-	-	0.01 ¹	1.00	-	2.03	0.04	0.12	-	0.02	0.24	0.80 ²
30,	-	-	0.01 ¹	1.00	-	3.47	7.92	5.80	1.03	2.99	2.51	5.33
Totals,	6.49	3.37	0.04	2.46	1.63	3.47	7.92	5.80	1.03	2.99	2.51	5.33

Total for the year 43.04 inches.

¹ Snow.² Rainfall included in that of following day.³ Rain and snow.

TABLE No. 4.—Rainfall in Inches at Chestnut Hill Reservoir, 1915.

DATE.	Amount.	Duration.	DATE.	Amount.	Duration.
Jan. 1, . . .	.05 ¹	11.20 A.M. to 4.30 P.M.	May 2, . . .	.19	10.45 P.M. to
Jan. 2, . . .	.03 ¹	11.05 P.M. to	May 3, . . .	.04	11.30 P.M. to 7.30 A.M.
Jan. 3, . . .			May 4, . . .		1.20 A.M.
Jan. 7, . . .	.72	3.55 A.M. to 9.30 A.M.	May 7, . . .	.16	5.45 P.M. to
Jan. 12, . . .	.207 ²	1.55 A.M. to	May 8, . . .	.13	8.00 A.M.
Jan. 13, . . .		6.10 A.M.	May 13, . . .	.25	12.30 P.M. to 10.00 P.M.
Jan. 18, . . .	.31 ¹	6.10 A.M. to 12.45 P.M.	May 17, . . .	.25	6.50 A.M. to 10.00 P.M.
Jan. 17, . . .	1.55	5.30 P.M. to	May 21, . . .	.55	1.00 P.M. to
Jan. 18, . . .			May 22, . . .		4.20 A.M.
Jan. 19, . . .	.05	8.15 A.M. to 8.30 A.M.	May 26, . . .	.16	11.30 A.M. to 6.45 P.M.
Jan. 23, . . .	.08 ¹	12.45 A.M. to 8.05 A.M.	Total, . . .	1.48	
Jan. 23, . . .	.45	8.05 A.M. to			
Jan. 24, . . .					
Jan. 24, . . .	.00 ¹	9.20 P.M. to			
Jan. 25, . . .					
Jan. 25, . . .	.23	7.30 A.M. to 11.00 A.M.			
Jan. 31, . . .	.45 ²	4.00 P.M. to			
Feb. 1, . . .					
		6.15 A.M.			
Total, . . .	6.89				
Feb. 1, . . .	.87 ²	9.20 A.M. to	June 6, . . .	.89	9.30 A.M. to 6.10 A.M.
Feb. 2, . . .		7.00 A.M.	June 8, . . .		
Feb. 2, . . .	.38 ¹	7.00 A.M. to	June 15, . . .	.04	7.45 A.M. to
Feb. 3, . . .			June 16, . . .		7.30 A.M.
Feb. 6, . . .	.29	4.25 A.M. to 10.30 A.M.	June 17, . . .	.50	2.35 A.M. to 1.15 P.M.
Feb. 7, . . .	.18 ²	10.15 P.M. to	June 19, . . .	.05	6.30 P.M. to 7.15 P.M.
Feb. 8, . . .			June 20, . . .	.14	12.15 P.M. to 2.45 P.M.
Feb. 12, . . .	.04	6.00 A.M. to 7.15 A.M.	June 26, . . .	.11	4.50 A.M. to 7.45 A.M.
Feb. 15, . . .	.70	12.45 A.M. to	June 30, . . .	4.19	11.05 P.M. to 7.30 A.M.
Feb. 16, . . .			July 1, . . .		
Feb. 16, . . .	.04	9.30 A.M. to 10.30 A.M.	Total, . . .	5.42	
Feb. 23, . . .	.07	6.00 P.M. to			
Feb. 24, . . .					
Feb. 24, . . .	.02	8.20 P.M. to			
Feb. 25, . . .					
		4.30 P.M.			
Total, . . .	3.44				
Apr. 3, . . .	.85 ¹	10.30 A.M. to	July 1, . . .	2.23	7.30 A.M. to
Apr. 4, . . .			July 3, . . .		4.35 A.M.
Apr. 6, . . .	.15	7.40 A.M. to 4.00 P.M.	July 4, . . .	.08	12.45 A.M. to 4.10 A.M.
Apr. 11, . . .	.16	6.15 P.M. to	July 5, . . .	.46	10.00 A.M. to 2.00 P.M.
Apr. 12, . . .			July 8, . . .	1.94	6.05 A.M. to
Apr. 16, . . .	.51	8.45 A.M. to 1.20 P.M.	July 9, . . .		1.15 A.M.
Apr. 26, . . .	.02	4.20 P.M. to 4.40 P.M.	July 11, . . .	.09	11.30 P.M. to
Apr. 30, . . .	1.23	6.15 A.M. to	July 12, . . .		3.05 A.M.
May 1, . . .			July 14, . . .	.12	4.05 A.M. to 4.50 A.M.
		7.30 A.M.	July 14, . . .	.17	1.20 P.M. to 4.10 P.M.
			July 17, . . .	.03	2.30 P.M. to 3.45 P.M.
			July 19, . . .	.16	4.40 P.M. to 11.05 P.M.
			July 21, . . .	.10	12.55 A.M. to 7.00 A.M.
			July 27, . . .	.86	12.55 A.M. to 7.15 A.M.
			July 27, . . .	.05	2.00 P.M. to 2.30 P.M.
			July 28, . . .	.62	9.40 P.M. to
			July 29, . . .		4.55 A.M.
			July 29, . . .	.34	3.30 P.M. to 4.50 P.M.
Total, . . .	2.92		Total, . . .	6.75	

¹ Snow.² Rain and snow.

TABLE No. 4.—Rainfall in Inches at Chestnut Hill Reservoir in 1915—
Concluded.

DATE.	Amount.	Duration.	DATE.	Amount.	Duration.
Aug. 2, .	.33	4.35 P.M. to 2.50 A.M.	Nov. 4, .	.33	7.00 P.M. to 8.00 P.M.
Aug. 3, .	.04	3.50 P.M. to 11.50 P.M.	Nov. 5, .	.06	8.00 P.M. to 11.25 P.M.
Aug. 4, .	.21	10.30 A.M. to 9.30 A.M.	Nov. 12, .	.70	9.15 P.M. to 11.55 A.M.
Aug. 7, .	.51	7.05 A.M. to 5.00 P.M.	Nov. 15, .	.96	11.00 A.M. to 7.00 P.M.
Aug. 9, .	.21	2.15 P.M. to 7.45 P.M.	Nov. 19, .	.06 ¹	1.10 A.M. to 5.30 A.M.
Aug. 10, .	.94	1.10 A.M. to 6.00 A.M.	Nov. 24, .	.26	10.45 A.M. to 3.00 P.M.
Aug. 13, .	1.42	7.00 A.M. to 2.50 A.M.	Total, .	2.38	
Aug. 22, .	.21	3.40 A.M. to 7.10 A.M.	Dec. 2, .	.06 ¹	2.40 P.M. to 5.30 P.M.
Aug. 23, .	.12	2.30 P.M. to 2.25 P.M.	Dec. 8, .	.09 ¹	8.45 A.M. to 6.05 A.M.
Aug. 25, .			Dec. 9, .	1.45	4.15 P.M. to 4.35 A.M.
Aug. 29, .			Dec. 13, .		
Aug. 30, .			Dec. 14, .	.07 ¹	4.35 A.M. to 8.45 A.M.
Total, .	6.89		Dec. 17, .	1.27	11.45 A.M. to 8.30 P.M.
Sept. 19, .	.16	3.15 A.M. to 9.25 A.M.	Dec. 18, .		
Sept. 21, .	.81	10.00 A.M. to 5.20 P.M.	Dec. 23, .	.28	12.30 P.M. to 12.35 A.M.
Sept. 24, .	.02	8.25 A.M. to 2.00 P.M.	Dec. 24, .		
Sept. 26, .	.03	1.50 P.M. to 6.00 P.M.	Dec. 25, .	.77	3.20 P.M. to 12.35 P.M.
Total, .	1.02		Dec. 26, .	.16 ¹	12.35 P.M. to 3.10 P.M.
Oct. 2, .	.17	1.30 A.M. to 1.30 A.M.	Dec. 28, .	.30	6.20 A.M. to 6.30 P.M.
Oct. 3, .	.43	9.45 A.M. to 7.45 A.M.	Dec. 29, .	.89 ¹	11.30 A.M. to 11.15 P.M.
Oct. 5, .	.57	8.45 P.M. to 11.15 A.M.	Total, .	5.33	
Oct. 6, .					
Oct. 7, .					
Oct. 8, .					
Oct. 15, .	.49	8.15 A.M. to 10.15 A.M.			
Oct. 20, .	.12	10.30 A.M. to 9.15 P.M.			
Oct. 26, .	.10	11.15 P.M. to 2.15 A.M.			
Oct. 27, .	.02	12.10 P.M. to 12.20 P.M.			
Total, .	2.90				

Total for year 44.92 inches.

¹ Snow.

METROPOLITAN WATER

[Pub. Doc.]

TABLE NO. 5.—Rainfall in Inches on the Wachusett Watershed,¹ 1897 to 1915.

YEAR.	January.	Febru-	March.	April.	May.	June.	July.	August.	Septem-	October.	Novem-	Decem-	Totals.
									Ber.				
1897,	.	.	3.46	2.86	4.01	2.32	5.06	5.11	8.65	3.47	1.93	0.94	7.63
1898,	.	.	6.66	3.30	2.27	4.43	3.38	3.11	3.01	10.61	3.15	7.21	6.41
1899,	.	.	2.93	5.12	6.75	1.94	1.33	5.51	3.83	3.20	4.11	2.73	1.94
1900,	.	.	4.56	8.69	6.19	2.76	4.34	3.59	3.20	3.18	3.46	2.90	6.44
1901,	.	.	1.75	1.13	5.82	9.64	7.02	1.51	5.66	4.58	3.10	3.70	2.42
1902,	.	.	2.72	4.91	5.27	4.36	2.24	2.61	3.87	3.95	4.26	6.36	9.36
1903,	.	.	2.85	4.42	6.58	3.10	1.24	10.37	3.43	3.88	2.93	4.43	2.36
1904,	.	.	4.02	2.66	3.40	7.45	2.99	3.44	3.84	3.68	5.30	1.78	1.63
1905,	.	.	6.10	1.72	8.96	2.60	0.83	4.88	5.39	3.09	6.90	1.81	2.53
1906,	.	.	2.59	2.74	5.17	3.12	6.58	5.95	5.52	4.34	2.61	3.95	2.26
1907,	.	.	2.84	2.32	1.82	2.65	2.96	3.54	3.03	1.26	9.50	6.68	5.74
1908,	.	.	3.40	4.82	3.77	2.62	5.34	1.20	3.85	6.49	1.04	2.13	1.05
1909,	.	.	3.62	6.10	4.38	5.71	2.65	3.03	4.25	3.59	3.90	1.70	1.68
1910,	.	.	5.86	5.24	1.09	3.01	2.13	4.36	1.52	3.87	2.86	1.40	4.17
1911,	.	.	2.91	2.43	3.70	2.23	1.59	2.37	2.83	5.46	3.04	6.24	4.14
1912,	.	.	2.57	2.42	5.69	4.06	5.76	0.48	2.65	2.89	2.17	2.53	4.02
1913,	.	.	3.38	2.55	5.83	3.90	3.71	0.90	2.37	3.05	4.44	6.03	2.59
1914,	.	.	3.40	3.58	4.33	4.91	3.01	2.00	8.93	4.50	0.15	2.97	3.89
1915,	.	.	6.31	3.33	0.06	1.80	1.67	3.18	8.60	6.90	1.83	3.05	3.13
Totals,	.	.	71.82	70.33	78.92	72.60	63.83	67.13	79.11	81.99	66.38	65.43	64.40
Average (19 years).	.	.	3.78	3.70	4.15	3.82	3.36	3.53	4.17	4.32	3.49	3.39	4.24

¹ Means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December, 1915, Princeton, Jefferson, Sterling and Boylston.

TABLE NO. 6.—Rainfall in Inches on the Sudbury Watershed,¹ 1875 to 1916.

YEAR.	January.	Febru- ary.	March.	April.	May.	June.	July.	August.	Septem- ber.	October.	Novem- ber.	Decem- ber.	Totals.
1875,	.	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.83	0.94	45.49
1876,	.	1.83	4.21	7.43	4.20	2.76	2.04	9.13	1.73	4.62	2.24	3.62	49.56
1877,	.	3.22	0.74	8.35	3.43	3.70	2.43	2.95	3.68	0.32	6.52	5.90	44.03
1878,	.	5.83	5.97	4.69	5.70	0.96	3.88	2.97	6.94	1.29	6.42	7.02	63.93
1879,	.	2.48	3.56	5.14	4.72	1.58	3.79	3.93	6.51	1.88	0.81	2.68	41.43
1880,	.	3.57	3.98	3.31	3.11	1.84	2.14	6.27	4.01	1.60	3.74	1.73	38.18
1881,	.	5.56	4.05	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96
1882,	.	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30
1883,	.	2.81	3.87	1.78	1.84	4.19	2.40	2.68	0.73	1.53	5.60	1.81	3.55
1884,	.	5.09	6.54	4.72	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	47.14
1885,	.	4.71	3.87	1.07	3.80	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.73
1886,	.	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97
1887,	.	5.20	4.78	4.90	4.27	1.16	2.65	3.76	5.28	1.32	2.83	2.67	3.88
1888,	.	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.90	7.22	5.40
1889,	.	5.37	2.37	3.41	2.95	2.30	8.94	4.18	4.60	4.25	6.29	3.14	49.95
1890,	.	2.53	3.51	7.73	2.64	5.21	2.03	2.46	3.87	6.00	10.51	5.31	53.00
1891,	.	7.02	5.23	6.48	3.91	2.01	3.77	3.39	4.73	2.38	3.09	3.68	49.53
1892,	.	5.85	3.14	4.06	0.83	5.58	2.76	4.23	4.44	2.94	1.17	5.80	1.13
1893,	.	2.92	8.20	3.67	3.60	6.61	2.88	2.57	6.41	1.74	4.07	2.20	4.86
1894,	.	4.09	3.91	1.43	3.43	4.24	1.15	3.26	2.03	5.34	3.43	4.81	30.74
1895,	.	4.06	1.39	2.98	6.26	2.02	2.77	6.04	4.16	2.30	10.68	6.63	3.35
1896,	.	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12
1897,	.	4.00	2.91	3.66	2.82	4.87	4.46	5.44	3.51	2.94	0.47	6.40	5.21
1898,	.	6.88	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.62	6.71	6.93	55.83
1899,	.	4.18	4.91	7.01	1.90	1.45	2.51	3.22	1.43	3.95	2.69	2.18	1.78
1900,	.	4.96	9.14	6.35	2.58	4.33	2.99	2.42	2.26	3.83	5.70	2.74	50.65

¹ See note at end of this table.

METROPOLITAN WATER

[Pub. Doc.]

TABLE No. 6.—Rainfall in Inches on the Sudbury Watershed,¹ 1875 to 1915—Concluded.

YEAR.	January.	Febru-	March.	April.	May.	June.	July.	August.	Septem-	October.	Novem-	Decem-	Totals.
									ber.				
1901,	.	1.82	1.52	6.57	8.60	7.23	1.38	5.71	4.57	3.30	2.83	2.90	9.69
1902,	.	2.52	6.18	5.34	4.13	1.86	2.88	2.94	3.40	4.54	4.44	1.45	6.38
1903,	.	3.80	6.63	2.99	0.93	9.25	2.77	3.67	1.75	4.72	1.56	3.14	45.16
1904,	.	4.87	3.00	2.72	8.87	2.65	2.80	1.96	3.86	5.80	1.64	1.73	2.92
1905,	.	5.26	2.20	8.15	2.72	1.31	6.00	5.47	7.70	6.88	1.54	2.07	4.01
1906,	.	2.47	2.92	6.32	2.88	5.66	3.91	3.42	3.02	3.20	3.40	2.69	4.49
1907,	.	3.28	2.17	1.91	3.41	3.63	3.63	1.86	1.07	8.76	4.17	6.12	4.47
1908,	.	3.60	4.56	3.82	1.88	5.51	0.86	3.71	4.57	0.97	2.55	0.98	3.14
1909,	.	3.98	5.79	4.26	4.67	2.43	2.81	1.59	2.93	4.74	1.12	3.35	4.05
1910,	.	5.39	5.06	0.85	2.75	1.29	4.68	2.03	2.62	2.49	1.86	4.13	2.49
1911,	.	2.88	2.77	3.59	2.81	1.01	2.53	3.19	4.94	2.75	3.69	4.62	3.60
1912,	.	2.94	2.77	6.46	4.37	4.55	0.46	3.24	3.24	3.05	1.76	2.35	3.64
1913,	.	3.17	2.82	5.75	4.25	3.97	1.98	3.60	3.64	3.77	5.53	2.85	3.18
1914,	.	3.85	4.07	4.57	5.10	3.08	1.90	3.44	3.82	0.29	1.60	2.83	3.46
1915,	.	6.51	3.58	0.06	2.48	1.74	3.65	8.12	5.87	1.10	2.95	2.79	5.09
Totals,	.	169.52	168.86	178.52	145.57	134.50	122.89	149.78	159.89	136.39	157.52	154.30	157.57
Average (41 years),	.	.	4.14	4.12	4.36	3.55	3.28	3.02	3.65	3.90	3.33	3.84	3.76

¹ Means of observations at several places, as follows: January, 1875, to March, 1876, inclusive, Lake Cochituate; April and May, 1876, Lake Cochituate, Westborough and Hopkinton; June to November, 1876, inclusive, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to December, 1882, inclusive, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to December, 1888, inclusive, Framingham and Westborough; January, 1890, to May, 1898, inclusive, Framingham and Ashland Dam; June, 1898, to December, 1915, inclusive, Framingham, Cordaville and Sudbury Dam.

TABLE No. 7.—Yield of the Wachusett Watershed in Gallons per Day per Square Mile¹ from 1897 to 1915.

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.
January,	.	.	796,000	1,563,000	2,092,000	796,000	619,000	1,676,000	1,265,000
February,	.	.	931,000	1,635,000	1,080,000	4,054,000	356,000	1,401,000	2,133,000
March,	.	.	2,760,000	3,058,000	2,776,000	3,722,000	2,718,000	3,982,000	3,423,000
April,	.	.	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000	2,238,000
May,	.	.	1,163,000	1,390,000	862,000	1,382,000	2,726,000	1,031,000	566,000
June,	.	.	1,181,000	828,000	561,000	578,000	935,000	410,000	2,131,000
July,	.	.	1,442,000	333,000	354,000	217,000	477,000	292,000	624,000
August,	.	.	896,000	1,325,000	236,000	197,000	612,000	287,000	474,000
September,	.	.	380,000	676,000	250,000	127,000	320,000	241,000	375,000
October,	.	.	243,000	1,569,000	245,000	283,000	647,000	980,000	689,000
November,	.	.	1,383,000	2,170,000	420,000	875,000	517,000	635,000	634,000
December,	.	.	2,275,000	2,061,000	359,000	1,370,000	3,234,000	1,848,000	954,000
Average,	.	.	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000	1,025,000
Average, driest six months,	.	.	886,000	1,013,000	312,000	377,000	576,000	471,000	626,000
									413,000
									541,000

¹ See note at end of this table.

TABLE No. 7.—Yield of the Wachusett Watershed in Gallons per Day per Square Mile¹ from 1897 to 1915—Concluded.

MONTH.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	Mean for 10 Years, 1897-1915.
January,	1,132,000	1,458,000	1,788,000	592,000	1,844,000	777,000	789,000	1,414,000	990,000	2,062,000	1,263,000
February,	1,027,000	692,000	1,736,000	2,536,000	1,845,000	625,000	927,000	1,181,000	1,941,000	1,888,000	
March,	1,880,000	1,697,000	2,192,000	2,138,000	2,640,000	1,239,000	2,831,000	2,263,000	3,127,000	572,000	2,457,000
April,	2,169,000	1,436,000	1,269,000	2,422,000	1,034,000	1,382,000	2,581,000	2,062,000	2,583,000	926,000	2,113,000
May,	1,633,000	945,000	1,415,000	1,212,000	603,000	461,000	1,797,000	1,038,000	1,699,000	455,000	1,171,000
June,	1,184,000	773,000	403,000	632,000	824,000	251,000	331,000	280,000	317,000	228,000	700,000
July,	728,000	335,000	220,000	238,000	62,000	57,000	125,000	19,000	329,000	1,083,000	411,000
August,	591,000	87,000	443,000	163,000	186,000	185,000	125,000	60,000	261,000	1,687,000	442,000
September,	277,000	810,000	88,000	208,000	145,000	181,000	89,000	219,000	-12,000	158,000	229,000
October,	630,000	1,352,000	158,000	90,000	718,000	145,000	673,000	126,000	357,000	504,000	
November,	749,000	2,540,000	126,000	363,000	354,000	1,036,000	442,000	660,000	211,000	468,000	753,000
December,	794,000	1,961,000	387,000	537,000	391,000	1,067,000	793,000	985,000	372,000	1,260,000	1,178,000
Average,	1,043,000	1,180,000	847,000	918,000	823,000	682,000	891,000	879,000	924,000	942,000	1,066,000
Average, driest six months,	613,000	726,000	288,000	270,000	201,000	227,000	210,000	318,000	208,000	666,000	522,000

¹ The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902 inclusive, 2.4 per cent. in 1903, 3.6 per cent. in 1904, 4.1 per cent. in 1905, 5.1 per cent. in 1906, 6.0 per cent. in 1907, 7.0 per cent. in 1908, 1909, and 1910, 6.5 per cent. in 1911, 6.8 per cent. in 1912, 6.9 per cent. in 1913, 7.4 per cent. in 1914 and 1915.

TABLE No. 8.—Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1915.

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.
January,	103,000	643,000	668,000	1,810,000	700,000	1,120,000	415,000	1,241,000	335,000	995,000	1,461,000	2,489,000	1,053,000	
February,	1,496,000	1,388,000	949,000	2,405,000	1,711,000	1,727,000	1,546,000	2,403,000	1,033,000	2,842,000	1,384,000	4,801,000	2,829,000	1,980,000
March,	1,604,000	4,435,000	4,814,000	3,507,000	2,830,000	1,374,000	4,004,000	2,839,000	1,611,000	3,725,000	1,572,000	2,059,000	2,868,000	2,328,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,169,000	1,546,000	867,000	1,380,000	2,863,000	1,815,000	1,947,000	2,620,000	2,645,000
May,	1,188,000	1,188,000	1,391,000	1,394,000	1,114,000	614,000	905,000	1,292,000	937,000	1,030,000	1,336,000	720,000	1,009,000	1,632,000
June,	870,000	223,000	597,000	506,000	413,000	175,000	1,328,000	559,000	300,000	416,000	426,000	203,000	413,000	421,000
July,	321,000	183,000	262,000	183,000	187,000	176,000	276,000	86,000	115,000	224,000	62,000	116,000	115,000	117,000
August,	396,000	405,000	121,000	476,000	395,000	119,000	148,000	55,000	79,000	267,000	240,000	94,000	214,000	379,000
September,	207,000	184,000	60,000	161,000	141,000	80,000	197,000	91,000	307,000	44,000	121,000	117,000	111,000	1,185,000
October,	646,000	234,000	631,000	516,000	71,000	102,000	186,000	269,000	186,000	83,000	336,000	146,000	190,000	1,999,000
November,	1,302,000	1,038,000	1,418,000	1,663,000	206,000	395,000	209,000	205,000	175,000	1,177,000	673,000	369,000	2,758,000	
December,	594,000	433,000	1,290,000	3,177,000	463,000	175,000	775,000	315,000	194,000	925,000	1,174,000	1,020,000	643,000	3,043,000
Average,	973,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000	533,000	1,129,000	901,000	1,687,000	1,154,000	1,607,000
Average, driest six months.	574,000	384,000	502,000	533,000	280,000	143,000	350,000	211,000	145,000	200,000	391,000	223,000	234,000	963,000

¹ See note at end of this table.

TABLE No. 8.—Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1915—Continued.

Month.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
JANUARY,	2,782,000	3,254,000	3,018,000	1,870,000	434,000	693,000	1,034,000	1,084,000	845,000	1,638,000	2,288,000	794,000	437,000	1,763,000
February,	1,196,000	1,529,000	3,486,000	943,000	1,542,000	991,000	541,000	2,976,000	1,067,000	3,022,000	1,381,000	3,800,000	300,000	1,674,000
MARCH,	1,338,000	3,843,000	4,463,000	1,985,000	3,245,000	2,410,000	2,328,000	3,835,000	2,585,000	2,804,000	4,205,000	3,684,000	2,735,000	4,199,000
APRIL,	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,940,000	2,515,000	1,494,000	1,515,000	1,629,000	2,521,000	1,350,000	4,204,000	1,885,000
MAY,	880,000	1,386,000	683,000	1,259,000	2,983,000	840,000	636,000	360,000	915,000	1,244,000	511,000	1,312,000	2,054,000	742,000
JUNE,	653,000	568,000	413,000	428,000	440,000	419,000	174,000	399,000	962,000	630,000	66,000	316,000	763,000	303,000
JULY,	634,000	107,000	149,000	214,000	158,000	161,000	231,000	95,000	658,000	231,000	19,000	—18,000	306,000	66,000
AUGUST,	1,432,000	132,000	163,000	280,000	181,000	209,000	229,000	57,000	591,000	1,107,000	—35,000	—34,000	424,000	135,000
SEPTEMBER,	823,000	457,000	203,000	229,000	108,000	150,000	89,000	388,000	182,000	369,000	94,000	65,000	306,000	175,000
OCTOBER,	1,230,000	2,272,000	210,000	126,000	222,000	374,000	1,379,000	592,000	94,000	1,160,000	115,000	184,000	413,000	506,000
NOVEMBER,	1,941,000	1,215,000	905,000	697,000	319,000	836,000	2,777,000	659,000	909,000	1,984,000	394,000	663,000	474,000	444,000
DECEMBER,	2,241,000	996,000	644,000	485,000	796,000	716,000	1,782,000	657,000	1,019,000	991,000	1,450,000	972,000	1,066,000	2,985,000
Average,	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000	356,000	460,000	314,000	564,000	777,000	93,000	194,000
Average, driest six months.	944,000	747,000	239,000	327,000	237,000									271,000

¹ See note at end of this table.

TABLE No. 8.—Yield of the Sudbury Watershed in Gallons per Square Mile¹ from 1875 to 1915—Concluded.

Month.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	Mean for 41 Years, 1876-1915.	
January,	-	1,736,000	477,000	1,128,000	1,351,000	1,925,000	392,000	1,490,000	519,000	728,000	1,041,000	988,000	1,629,000	1,196,000	
February,	-	2,279,000	882,000	339,000	1,041,000	624,000	1,538,000	2,286,000	1,849,000	700,000	1,197,000	754,000	1,009,000	1,870,000	1,694,000
March,	-	3,454,000	2,989,000	2,497,000	1,658,000	2,257,000	1,734,000	1,954,000	1,144,000	3,092,000	2,090,000	3,028,000	583,000	2,733,000	
April,	-	2,261,000	3,294,000	1,663,000	1,949,000	1,607,000	1,117,000	1,721,000	667,000	1,426,000	2,235,000	2,232,000	2,353,000	690,000	1,976,000
May,	-	351,000	1,745,000	297,000	1,059,000	888,000	1,046,000	1,004,000	277,000	318,000	1,447,000	867,000	1,550,000	245,000	1,055,000
June,	-	1,887,000	419,000	467,000	707,000	761,000	194,000	239,000	516,000	213,000	148,000	149,000	5,000	101,000	467,000
July,	-	445,000	62,000	177,000	388,000	9,000	-14,000	-121,000	-102,000	-14,000	-77,000	-82,000	107,000	1,045,000	174,000
August,	-	307,000	170,000	114,000	180,000	-104,000	102,000	-45,000	-73,000	20,000	-39,000	-54,000	156,000	1,198,000	248,000
September,	-	130,000	397,000	1,246,000	19,000	541,000	-82,000	149,000	5,000	76,000	-28,000	88,000	-135,000	38,000	221,000
October,	-	492,000	191,000	183,000	301,000	741,000	47,000	-51,000	-51,000	296,000	-14,000	484,000	-59,000	231,000	421,000
November,	-	363,000	289,000	279,000	483,000	1,998,000	71,000	82,000	176,000	593,000	165,000	480,000	97,000	261,000	760,000
December,	-	582,000	286,000	887,000	659,000	2,032,000	186,000	263,000	221,000	908,000	494,000	732,000	250,000	888,000	974,000
Average,	-	1,190,000	931,000	785,000	860,000	1,010,000	694,000	625,000	570,000	514,000	779,000	753,000	772,000	719,000	988,000
Average, driest six months.	-	388,000	228,000	403,000	341,000	471,000	44,000	40,000	29,000	161,000	26,000	180,000	28,000	480,000	379,000

1 The area of the Sudbury watershed used in these records included water surfaces amounting to 1.0 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894, and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

Note.—The recorded yields, subsequent to the year 1877, are less accurate than those for previous years, particularly during months of small yield, due to unavoidable inaccuracies in the measurement of large quantities of water received from the Wachusett Reservoir.

TABLE No. 9.—Wachusett System.—Statistics of Flow of Water, Storage and Rainfall in 1915.
[Waterted above dam = 103.34 square miles.]

MONTH.	Received from City of Worcester or Waterned.	Discharged into Wachusett Aqueduct. ¹	Wasted into River below Dam.	GALLONS PER DAY.			Rainfall collected (Inches).	Percent-age of Rainfall collected.		
				STORAGE. ²		Total Yield of Watershed.				
				Gain.	Loss.					
January,	300,000	63,703,000	2,677,000	805,000	166,023,000	-	224,416,000*	6.31		
February,	15,889,000	46,889,000	2,363,000	871,000	179,143,000	-	213,407,000	3.32		
March,	2,609,000	87,320,000	2,260,000	925,000	-	26,168,000	63,265,000	.06		
April,	500,000	74,387,000	2,020,000	920,000	23,480,000	-	100,817,000	1.80		
May,	800,000	59,941,000	2,763,000	925,000	-	13,397,000	49,460,000	1.67		
June,	573,000	67,240,000	3,723,000	925,000	-	36,620,000	24,753,000	3.18		
July,	4,268,000	91,097,000	3,597,000	910,000	26,532,000	-	117,387,000	8.60		
August,	18,035,000	73,203,000	2,461,000	945,000	116,762,000	-	160,306,000	6.90		
September,	3,043,000	82,223,000	2,876,000	960,000	-	65,383,000	17,183,000	1.53		
October,	2,577,000	79,084,000	2,748,000	920,000	-	38,078,000	43,106,000	3.05		
November,	400,000	65,823,000	3,610,000	910,000	-	15,700,000	54,153,000	3.12		
December,	1,000,000	68,948,000	3,439,000	900,000	75,632,000	-	147,839,000	5.11		
Total,	-	-	-	-	-	-	44,479,000	44.36		
Average for year,	3,973,000	70,281,000	2,880,000	910,000	32,058,000	-	102,479,000	-		

¹ Including 158,000 gallons per day drawn from aqueduct for the supply of the Westborough State Hospital.

² Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

* Includes 1,510,000 gallons per day pumped from Wachusett Reservoir by the City of Worcester.

TABLE No. 10.—*Sudbury System.*—*Statistics of Flow of Water, Storage and Rainfall in 1915.*

[Watershed from 1875 to 1878 inclusive=77.764 square miles; in 1879 and 1880=78.258 square miles; and from 1881 to 1915 inclusive=76.2 square miles.]

MONTH.	Water received from Wachusett Reservoir, ¹	Water discharged through Sudbury Aqueduct.	Water used by Framingham Water Works.	Water diverted from Watershed by Sewers, etc.	STORAGE.		Rain-fall (Inches).	Rain-fall collected (Inches).	Percentage of Rain-fall collected.
					Gain.	Loss.			
January,	63,519,000	65,710,000	36,610,000	861,000	1,226,000	68,380,000	2,530,000	-	122,497,000
February,	46,983,000	64,661,000	36,370,000	897,000	1,439,000	92,897,000	-	8,970,000	140,611,000
March,	37,635,000	60,461,000	36,726,000	735,000	1,03,000	31,755,000	1,481,000	-	44,626,000
April,	74,710,000	57,917,000	35,450,000	743,000	976,000	14,727,000	9,284,000	-	44,337,000
May,	59,724,000	57,271,000	36,726,000	784,000	826,000	13,569,000	-	30,165,000	19,177,000
June,	57,150,000	66,063,000	34,417,000	797,000	600,000	2,780,000	-	39,910,000	7,597,000
July,	90,903,000	58,906,000	33,555,000	732,000	1,886,000	47,239,000	27,688,000	-	78,013,000
August,	73,026,000	60,040,000	33,626,000	753,000	1,687,000	63,613,000	11,107,000	-	87,815,000
September,	82,103,000	68,997,000	33,087,000	823,000	873,000	7,586,000	-	26,370,000	2,893,000
October,	78,903,000	65,385,000	29,462,000	816,000	829,000	13,749,000	-	13,947,000	17,261,000
November,	66,617,000	76,043,000	19,610,000 ²	787,000	743,000	17,994,000	-	29,920,000	19,640,000
December,	68,754,000	58,303,000	37,726,000	761,000	1,065,000	40,548,000	-	2,084,000	87,555,000
Total,	-	-	-	-	-	-	-	-	-
Av. for year,	70,092,000	63,261,000	33,624,000	783,000	1,085,000	33,547,000	-	8,126,000	54,980,000
							-	-	-
							-	-	34.3

¹ Not including 188,000 gallons per day drawn from the Wachusett Aqueduct for the supply of the Westborough State Hospital, which were not discharged into Sudbury Reservoir.

² Includes 617,000 gallons per day wasted cleaning the aqueduct.

TABLE No. 11.—Cochituate System.—Statistics of Flow of Water, Storage and Rainfall in 1915.
[Watershed of lake=17.88 square miles.¹]

MONTH.	Water discharged through Cochituate Aqueduct.	Water diverted from Watershed by Sewers, etc.	Rainfall at Outlet of Lake.	GALLONS PER DAY.		Total Yield of Watershed.	Rainfall collected (Inches).	Percentage of Rainfall collected.
				GAIN.	LOSS.			
January,	-	639,000	33,016,000	-	1,000,000	32,655,000	6.57	3.31
February,	-	1,104,000	45,080,000	-	7,468,000	38,725,000	3.88	3.55
March,	-	948,000	8,461,000	1,866,000	-	11,274,000	0.01	1.14
April,	-	947,000	-	9,365,000	-	10,210,000	2.82	1.00
May,	-	584,000	-	3,410,000	-	3,994,000	1.59	0.40
June,	-	577,000	-	1,020,000	-	1,597,000	3.51	0.16
July,	-	1,219,000	12,168,000	5,048,000	-	18,455,000	8.38	1.87
August,	-	1,652,000	16,983,000	-	306,000	18,299,000	5.72	1.85
September,	-	783,000	1,473,000	-	653,000	1,703,000	0.88	0.17
October,..	-	616,000	5,288,000	-	616,000	5,358,000	2.95	0.64
November,	-	563,000	10,914,000	-	4,730,000	6,777,000	2.58	0.67
December,	-	877,000	22,988,000	-	4,377,000	19,498,000	5.48	1.98
Total,	-	-	-	-	-	-	44.35	16.64
Average for year,	-	861,000	12,882,000	189,000	-	18,982,000	-	37.5

¹ Not including the watersheds of Dudley and Dug ponds.

TABLE No. 12.—Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.

Date.	Cheney Hill Reservoir.	Lake Cochituate.	Farm Pond.	Spot Pond.	Weston Reservoir.	High Water = 163.00.	High Water = 163.26.	Franklin Reservoir.			Ashland Reservoir.	Sudbury Reservoir.	Hopkinton Reservoir.	Flash Boards 226.23.	Flash Boards 250.97.	Flash Boards 305.00.	Whitehall Reservoir.	Wachusett Reservoir.
								No. 1.	No. 2.	No. 3.								
Jan. 1, 1915,	133.92	132.82	133.66	132.55	200.00	167.66	175.98	183.03	224.34	267.81	304.05	337.66	381.89					
Feb. 1, 1915,	133.82	142.46	135.11	162.73	199.97	167.33	176.13	183.03	224.47	267.93	304.20	337.63	385.94					
Mar. 1, 1915,	133.86	141.61	139.36	162.85	200.03	168.98	176.36	183.00	223.05	257.75	302.68	337.34	389.81					
April 1, 1915,	133.92	141.73	138.75	162.75	199.96	167.70	176.00	183.00	224.40	267.76	303.39	337.28	389.46					
May 1, 1915,	134.03	143.08	138.48	163.06	199.69	169.65	177.37	183.16	221.26	267.51	305.07	337.70	389.93					
June 1, 1915,	134.00	143.59	138.01	162.88	200.12	169.37	177.21	183.04	225.28	255.22	305.00	337.76	389.66					
July 1, 1915,	134.18	143.72	157.73	163.93	200.06	169.49	177.33	183.40	225.42	251.86	305.18	337.78	388.88					
Aug. 1, 1915,	133.90	144.38	157.97	163.87	200.00	169.46	177.28	183.96	225.37	254.24	305.06	337.89	389.42					
Sept. 1, 1915,	133.99	144.34	138.00	162.75	200.08	169.45	177.23	183.03	225.34	255.15	305.02	337.86	389.17					
Oct. 1, 1915,	133.90	144.27	157.59	162.65	199.96	168.69	177.18	184.10	225.30	253.11	304.85	337.70	389.77					
Nov. 1, 1915,	134.05	144.19	157.63	162.57	199.85	167.60	175.96	184.34	225.26	252.06	304.95	337.88	389.82					
Dec. 1, 1915,	133.91	143.59	157.60	162.77	200.00	167.70	176.98	182.88	224.37	250.15	304.12	337.64	389.39					
Jan. 1, 1916,	133.89	142.93	157.87	162.90	199.80	167.80	176.19	184.48	224.53	249.53	304.24	337.29	391.05					

TABLE No. 13.—*Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District.*

From Wachusett Reservoir into the Wachusett Aqueduct.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	15	152	22	1,664.8
February,	14	122	14	1,312.9
March,	27	264	27	2,722.7
April,	25	234	-	2,246.9
May,	15	169	30	1,858.8
June,	16	191	52	1,720.2
July,	24	242	-	2,824.0
August,	26	334	52	2,269.3
September,	20	416	5	2,468.5
October,	27	364	15	2,451.6
November,	25	227	30	1,974.7
December,	26	251	50	2,138.0
Totals,	260	2,970	57	25,652.4

Total actual time, 123.79 days.

Total quantity drawn, 25,652,400,000 gallons.

From Sudbury Reservoir through the Weston Aqueduct to Weston Reservoir.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	31	744	-	1,134.9
February,	28	672	-	1,018.6
March,	31	744	-	1,138.5
April,	30	693	30	1,063.5
May,	31	744	-	1,138.5
June,	30	716	15	1,032.5
July,	31	744	-	1,040.2
August,	31	744	-	1,042.4
September,	30	708	15	992.6
October,	28	648	-	913.1
November,	17	398	30	569.8
December,	31	741	-	1,169.5
Totals,	349	8,297	30	12,254.1

Total actual time, 345.73 days.

Total quantity drawn, 12,254,100,000 gallons.

TABLE No. 13 — *Concluded.**From Framingham Reservoir No. 3 through the Sudbury Aqueduct to Chestnut Hill Reservoir.*

MONTH.	Number of Days during which Water was flowing.	Actual Time (Hours).	Million Gallons drawn.
January,	31	744	2,037.0
February,	28	672	1,810.5
March,	31	744	1,874.3
April,	30	720	1,737.5
May,	31	744	1,775.4
June,	30	720	1,981.9
July,	31	744	1,826.1
August,	31	744	1,862.8
September,	30	720	2,069.9
October,	31	744	2,026.3
November,	30	720	2,281.3
December,	31	744	1,807.4
Totals,	365	8,760	23,090.4

Total actual time, 365 days.

Total quantity drawn, 23,090,400,000 gallons.

TABLE No. 14. — *Average Daily Quantity of Water flowing through Aqueducts in 1915 by Months.¹*

MONTH.	Wachusett Aqueduct into Sudbury Reservoir (Gallons).	Weston Aqueduct into Metropolitan District (Gallons).	Sudbury Aqueduct into Chestnut Hill Reservoir (Gallons).	Cochituate Aqueduct into Chestnut Hill Reservoir (Gallons).
January,	53,519,000	36,610,000	65,710,000	-
February,	46,693,000	36,379,000	64,861,000	-
March,	87,835,000	36,726,000	60,461,000	-
April,	74,710,000	35,450,000	57,917,000	-
May,	59,784,000	36,726,000	57,271,000	-
June,	57,150,000	34,417,000	66,063,000	-
July,	90,903,000	33,555,000	58,906,000	-
August,	73,026,000	33,626,000	60,090,000	-
September,	82,103,000	33,087,000	68,997,000	-
October,	78,903,000	29,452,000	65,365,000	-
November,	65,617,000	18,993,000	76,043,000	-
December,	68,764,000	37,726,000	58,803,000	-
Average,	70,092,000	33,573,000	63,261,000	-

¹ Not including quantities wasted while cleaning and repairing aqueducts.

TABLE No. 15.—Statement of Operation of Engines Nos. 1 and 2 at Chestnut Hill Pumping Station No. 1 for the Year 1915.

(3 per cent. allowed for slip.)

MONTH.	ENGINE No. 1.		ENGINE No. 2.		AVERAGE Lift (Feet).
	Total Pumping Time. Hrs. Min.	Quantity Pumped (Million Gallons).	Total Pumping Time. Hrs. Min.	Quantity Pumped (Million Gallons).	
January,	277 35	92.55	-	92.55	16,390 9.3
February,	236 55	79.13	-	79.13	183,230 9.0
March,	165 25	54.37	-	54.37	223,805 5.9
April,	56 10	18.67	-	18.67	73,440 12.6
May,	14 35	4.77	-	4.77	16,750 16.9
June,	-	-	-	-	5,730 605
July,	-	-	-	-	6,280 740
August,	-	-	-	-	7,165 780
September,	92 20	38.44	-	32.44	74,265 14.6
October,	20 05	7.27	-	7.27	30,990 10.9
November,	-	-	-	-	35,285 4,760
December,	-	-	-	-	66,170 7,920
Total,	863 25	289.20	-	289.20	904,430 87,080
Average,	-	-	-	-	-

Duty in Foot-pounds
per 100 Pounds of Coal,
corrected for Heat loss;
duty for Heating or Light-
ing.

Duty in Foot-pounds
per 100 Pounds of Coal,
corrected for Heat loss;
duty for Heating or Light-
ing.

Per cent. of Ashes and
Clinker.

Gallons pumped
per Pound of Coal.

Total Ashes and Clinker
(Pounds).

Total Coal consumed
(Pounds).

Total Quantity pumped
(Million Gallons).

Quantity pumped for Slip
(Million Gallons).

Total Pumping Time.
Hrs. Min.

Hrs. Min.

Duty in Foot-pounds
per 100 Pounds of Coal,
corrected for Heat loss;
duty for Heating or Light-
ing.

Duty in Foot-pounds
per 100 Pounds of Coal,
corrected for Heat loss;
duty for Heating or Light-
ing.

Per cent. of Ashes and
Clinker.

Gallons pumped
per Pound of Coal.

Total Ashes and Clinker
(Pounds).

Total Coal consumed
(Pounds).

Total Quantity pumped
(Million Gallons).

Quantity pumped for Slip
(Million Gallons).

Total Pumping Time.
Hrs. Min.

Hrs. Min.

TABLE No. 16.—*Statement of Operation of Engine No. 4 at Chestnut Hill Pumping Station No. 1 and Summary for the Station for the Year 1916.*

[2 per cent. allowed for slip.]

TABLE No. 17.—Statement of Operation of Engines Nos. 5, 6 and 7 at Chestnut Hill Pumping Station No. 2 for the Year 1915.

[2 per cent. allowed for slip.]

TABLE No. 18.—Statement of Operation of Engine No. 12 at Chestnut Hill Pumping Station No. 2 for the Year 1915.

[2 per cent. allowed for slip.]

Month.	Total Pumping Time.	Quantity Pumped, one-Gallons.	Cost consumed (Pounds).	Ashes and Clinker (Pounds).	Per cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal; no Decrease for Heating.	Average Lift (Ft.).	Duty in Foot-pounds per 100 Pounds of Coal; on Basis of 100% Efficiency.	Duty in Foot-pounds per 100 Pounds of Coal; no Decrease for Heating.	Duty in Foot-pounds per 100 Pounds of Coal; no Decrease for Heating.	Duty in Foot-pounds per 100 Pounds of Coal; no Decrease for Heating.
January,	.	.	.	-	-	-	-	-	-	-	-
February,	.	.	.	-	-	-	-	-	-	-	-
March,	.	.	.	-	-	-	-	-	-	-	-
April,	575	15	729.64	486,440	64,915	13.9	1,564.27	121.71	158,590,000	161,810,000	158,590,000
May,	734	55	969.57	631,165	87,740	13.9	1,536.16	123.56	158,110,000	161,320,000	158,110,000
June,	717	10	933.62	666,355	92,440	13.9	1,401.13	124.37	154,450,000	157,620,000	154,450,000
July,	740	20	930.38	648,980	88,320	13.7	1,626.07	123.33	156,780,000	159,960,000	156,780,000
August,	740	35	934.98	675,845	81,410	12.0	1,457.41	123.49	149,920,000	152,960,000	149,920,000
September,	714	10	937.38	676,705	78,915	11.7	1,459.10	122.18	148,500,000	151,510,000	148,500,000
October,	742	05	939.65	685,555	85,300	12.4	1,458.16	123.12	149,550,000	152,990,000	149,550,000
November,	713	50	951.37	632,015	78,625	12.1	1,459.12	123.81	150,430,000	153,530,000	150,430,000
December,	738	45	1,013.32	635,650	72,285	10.5	1,478.78	123.37	151,970,000	155,050,000	151,970,000
Total,	6,417	05	8,620.42	5,758,640	736,550	-	-	-	123.26	149.20	149.20
Average,	-	-	-	-	-	-	-	-	152,990,000	156,990,000	156,990,000

TABLE No. 19.—Statement of Operation of Engine No. 8 at Snot Pond Pumping Station for the Year 1915.

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.	Quantity Pumped, one-million Gallons.	Cost of Consumed Oil.	Aches and Clinker.	Per cent. of Ashes and Clinker.	Gallons Pumped per Hour.	Gallons Pumped per Hour.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Higher Deadhead for Heating or Lightening.	Duty in Foot-pounds per 100 Pounds of Coal, no Deadhead for Heating or Lightening.	Duty in Foot-pounds per 100 Pounds of Coal, no Deadhead for Heating or Lightening.	
									Hrs.	Min.	Sec.	Sec.	Sec.
January,	-	-	-	-	-	-	-	-	10	30	4.55	4,155	605
February,	-	-	-	-	-	-	-	-	-	-	-	-	-
March,	-	-	-	-	-	-	-	-	-	-	-	-	-
April,	-	-	-	-	-	-	-	-	-	-	-	-	-
May,	-	-	-	-	-	-	-	-	10	35	4.42	4,840	595
June,	-	-	-	-	-	-	-	-	12	00	5.30	4,805	565
July,	-	-	-	-	-	-	-	-	-	-	-	-	-
August,	-	-	-	-	-	-	-	-	-	-	-	-	-
September,	-	-	-	-	-	-	-	-	-	-	-	-	-
October,	-	-	-	-	-	-	-	-	-	-	-	-	-
November,	-	-	-	-	-	-	-	-	9	30	4.19	4,880	695
December,	-	-	-	-	-	-	-	-	-	-	-	-	-
Total,	-	-	-	-	-	-	-	-	42	36	18.46	18,690	2,450
Average,	-	-	-	-	-	-	-	-	-	-	-	18.1	988.22
									-	-	-	112.25	92,400,000
									-	-	-	-	94,300,000

TABLE No. 20.—*Statement of Operation of Engines No. 9 at Spot Pond Pumping Station for the Year 1915.*

[2 per cent. allowed for slip.]

TABLE No. 21.—Statement of Operation of Engine No. 10 at Arlington Pumping Station for the Year 1915.

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.	Quantity Pumped (Gallons).		Coal Consumed (Pounds).		Ashes and City Water (Pounds).		Per cent. of Ashes and Charcoal.		Gallons Pumped per Pound of Coal; no Decrease for Heating or Lighting.		Average Lift (Feet).		Duty in Foot-pounds per 100 Pounds of Coal, no Decrease for Heating or Lighting.		Duty in Foot-pounds per 100 Pounds of Coal, no Decrease for Heating or Lighting.	
		Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.
January,	.	.	.	19.26	30	90,620	6,501	8.1	238.77	278.99	55,450,000	56,450,000	56,450,000	56,450,000	56,450,000	56,450,000	
February,	.	.	.	16.86	30	72,135	5,919	8.2	233.73	279.48	54,410,000	55,350,000	55,350,000	55,350,000	55,350,000	55,350,000	
March,	.	.	.	18.69	15	79,035	6,480	8.2	236.48	279.73	55,100,000	56,050,000	56,050,000	56,050,000	56,050,000	56,050,000	
April,	.	.	.	19.01	00	76,880	6,876	8.9	246.95	280.26	57,050,000	58,000,000	58,000,000	58,000,000	58,000,000	58,000,000	
May,	.	.	.	16.57	00	67,640	5,940	8.8	244.97	281.66	57,980,000	58,470,000	58,470,000	58,470,000	58,470,000	58,470,000	
June,	.	.	.	26.97	40	96,185	7,969	8.3	280.40	287.66	67,190,000	68,350,000	68,350,000	68,350,000	68,350,000	68,350,000	
July,	.	.	.	21.48	00	82,345	8,742	10.6	260.83	283.90	61,460,000	62,520,000	62,520,000	62,520,000	62,520,000	62,520,000	
August,	.	.	.	20.98	30	80,565	7,579	9.4	260.41	280.03	60,740,000	61,790,000	61,790,000	61,790,000	61,790,000	61,790,000	
September,	.	.	.	25.40	30	95,035	9,677	10.2	267.59	282.54	62,980,000	64,070,000	64,070,000	64,070,000	64,070,000	64,070,000	
October,	.	.	.	21.73	00	86,345	9,265	10.7	261.66	280.65	58,580,000	61,570,000	61,570,000	61,570,000	61,570,000	61,570,000	
November,	.	.	.	15.27	00	65,945	6,786	10.3	231.56	280.97	54,300,000	55,140,000	55,140,000	55,140,000	55,140,000	55,140,000	
December,	.	.	.	19.33	00	88,220	8,670	10.4	232.38	280.01	64,180,000	65,120,000	65,120,000	65,120,000	65,120,000	65,120,000	
Total,	.	241.54	-	966,060	90,434	-	-	9.4	250.08	281.50	-	-	-	-	-	-	
Average,	.	-	-	-	-	-	-	-	-	-	58,630,000	59,640,000	59,640,000	59,640,000	59,640,000	59,640,000	

TABLE No. 22.—Statement of Operation of Engine No. 11 at Arlington Pumping Station for the Year 1915.
[4 per cent. allowed for slip.]

[4 per cent. allowed for slip.]

Month.	Summary of Engines Nos. 10 AND 11.		
	Total Pumping Time.	Quantity pumped, cor- rected for Slip (Million Gallons).	Cost, consumed (Pounds).
January,	-	-	-
February,	-	-	-
March,	-	-	-
April,	143.00	4.66	30,510
May,	5.15	.27	1,685
June,	-	-	-
July,	-	-	-
August,	2.00	.02	-
September,	-	-	-
October,	133.30	4.18	25,765
November,	-	-	-
December,	-	-	-
Total,	283.45	9.18	57,960
Average,	-	-	-

TABLE No. 23.—Statement of Operation of Engines Nos. 13 and 14 at Hyde Park Pumping Station for the Year 1915.

[2 per cent. allowed for slip.]

MONTH.	Engine No. 13.	Engine No. 14.	Total Pumping Time.	Quantity Pumped (Million Gallons).	Total Pumping Time. (Million Gallons).	Quantity Pumped (Million Gallons), corrected for Slip.	Total Pumping Time. (Million Gallons).	Total Ashes and Clinker (Pounds).	Gallons pumped per Pound of Coal, corrected for Slip; no Deducted for Heating or Lighting.	Duty in Foot-pounds per 100 Pounds of Coal, corrected for Slip; no Deducted for Heating or Lighting.	Duty in Foot-pounds per 100 Pounds of Coal, no Deducted for Heating or Lighting.	Duty in Foot-pounds per 100 Pounds of Coal, no Deducted for Heating or Lighting; no Deducted for Heating or Lighting.	Average Unit (Ft.-lb.).	Engine No. 14.	Engine No. 13.	Duty in Foot-pounds per 100 Pounds of Coal, no Deducted for Heating or Lighting.
January,	-	-	372 26	21.64	21.64	43,401	5,519	12.7	498.61	-	125.66	52,190,000	53,310,000	53,310,000		
February,	32 00	2.24	221 15	17.41	19.65	37,947	4,478	11.8	517.83	123.30	124.39	53,610,000	54,700,000	54,700,000		
March,	-	-	272 20	18.69	18.69	40,761	4,733	11.6	453.53	-	126.09	48,160,000	49,200,000	49,200,000		
April,	91 55	3.24	449 15	16.50	19.74	41,756	4,835	11.6	472.75	120.55	120.59	47,480,000	48,500,000	48,500,000		
May,	-	-	582 05	22.53	22.53	43,549	4,823	11.1	517.35	-	121.69	52,440,000	53,570,000	53,570,000		
June,	23 00	.94	551 30	22.76	23.70	44,669	4,876	10.9	530.57	120.90	121.99	53,890,000	55,050,000	55,050,000		
July,	-	-	275 25	20.97	20.97	43,140	5,412	12.5	486.99	-	132.64	53,710,000	54,860,000	54,860,000		
August,	163 20	8.04	237 55	16.33	24.37	42,493	4,884	11.5	573.51	86.85	130.71	52,340,000	53,470,000	53,470,000		
September,	-	-	309 05	19.31	19.31	38,038	3,925	10.3	507.65	-	129.96	54,980,000	56,140,000	56,140,000		
October,	129 00	4.53	441 00	16.66	21.18	44,107	4,861	11.0	480.20	121.33	122.04	45,750,000	49,800,000	49,800,000		
November,	159 20	5.78	387 30	13.88	19.71	42,341	4,857	11.0	465.51	120.04	120.57	46,720,000	47,720,000	47,720,000		
December,	569 55	19.48	-	-	19.48	42,504	4,826	11.4	458.31	122.19	-	46,650,000	47,650,000	47,650,000		
Total,	1,168 30	44.24	4,099 45	206.73	250.97	504,706	57,828	-	-	-	-	-	-	-		
Average,	-	-	-	-	-	-	-	-	11.5	497.26	111.62	125.23	50,880,000	51,970,000	51,970,000	

TABLE No. 24.—(Meter Basis.) Average Daily Consumption of Water by Districts in the Cities and Towns supplied by the Metropolitan Water Works in 1915. (For Consumption of Water in Whole Metropolitan Water District, see Table No. 27.)

Month.	Boston, excluding East Boston and Charlestown (Gallons).	SOUTHERN LOW SERVICE.	NORTHERN LOW SERVICE.	SOUTHERN HIGH SERVICE.	NORTHERN HIGH SERVICE.	Lexington and Portions of Arlington and Belmont (Gallons).	Total District supplied (Gallons).	Estimated Population.	Consumption per Inhabitant (Gallons).
		Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston, and Arlington (Gallons).	Quincy, Watertown, and Portions of Boston, Belmont and Milton (Gallons).	Revere, Swampscott, Nahant, Stone- ham, Melrose, and Portions of Boston, Charles, Everett, Malden, Medford and Somerville (Gallons).					
January,	47,152,600	20,516,100	33,193,500	7,129,900	681,700	623,300	109,297,100	1,151,800	95
February,	46,437,000	20,358,400	31,872,900	7,011,400	701,700	571,800	106,953,200	1,153,930	93
March,	43,083,300	18,868,000	30,178,400	6,757,800	602,900	604,100	100,044,900	1,156,060	87
April,	40,408,700	18,429,300	30,116,500	6,955,500	658,000	645,800	97,213,800	1,158,190	84
May,	40,588,900	18,790,400	31,070,900	7,369,400	726,800	702,400	98,158,900	1,160,330	85
June,	42,863,500	19,899,400	32,286,800	8,312,800	790,000	916,800	104,870,300	1,162,460	90
July,	42,243,100	19,378,600	31,572,800	8,030,300	676,500	698,900	102,620,200	1,164,800	88
August,	41,680,700	19,135,800	31,435,900	7,817,300	572,500	683,300	101,304,600	1,166,740	87
September,	40,921,400	20,296,900	33,802,600	8,236,900	643,600	864,700	104,670,100	1,168,870	90
October,	40,011,000	19,140,000	32,984,300	7,394,500	683,200	717,700	100,030,700	1,171,010	85
November,	39,219,600	18,737,400	31,305,500	6,988,100	657,100	655,400	97,575,100	1,173,140	83
December,	39,605,200	19,780,800	32,408,000	6,754,800	650,800	650,800	98,918,000	1,175,280	85
For the year,	41,976,400	19,428,700	31,775,400	7,398,200	668,000	694,800	101,941,500	1,164,600	88

In addition to the above quantities the United States Government Reservation on Peddock's Island was supplied with 28,152,000 gallons, equivalent to a daily average of 77,100 gallons, and a part of Saugus with 5,372,000 gallons, equivalent to a daily average rate of 14,700 gallons.

TABLE No. 25.—(Meter Basis.) Average Daily Consumption of Water in Cities and Towns supplied by the Metropolitan Water Works in 1915.

Month.	Boston.		SOMERVILLE.		MALDEN.		CHARLES.		EVERETT.		QUINCY.		MEDFORD.	
	Population.		\$76,880.		49,160.		45,750.		27,950.		40,340.		26,528.	
	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.
January,	85,039,600	115	6,309,600	73	2,063,300	42	2,796,800	65	2,760,600	74	2,378,300	59	1,224,900	41
February,	82,973,500	112	6,151,300	71	2,090,300	43	2,839,800	66	2,715,300	72	2,896,400	60	1,371,000	45
March,	77,156,100	104	5,648,900	65	2,092,900	43	2,769,000	64	2,458,100	65	2,301,400	57	1,188,300	39
April,	74,279,200	100	5,592,200	63	2,122,100	43	2,735,800	63	2,444,900	65	2,314,700	57	1,177,900	39
May,	75,158,100	101	5,677,000	65	2,382,200	47	2,833,000	65	2,353,600	63	2,487,400	61	1,209,000	39
June,	78,291,800	105	6,052,900	69	2,532,900	51	2,933,100	69	2,603,700	69	2,757,300	67	1,309,400	43
July,	77,347,100	103	5,983,200	68	2,157,600	44	2,943,400	67	2,562,600	68	2,738,300	67	1,204,700	39
August,	76,915,300	103	5,526,000	63	2,177,300	44	3,027,200	69	2,576,800	68	2,825,200	64	1,159,200	37
September,	78,497,700	104	5,979,100	68	2,485,900	50	3,159,500	72	2,718,400	71	2,899,400	66	1,316,300	42
October,	75,888,400	101	5,668,400	65	2,999,000	49	2,967,500	67	2,641,600	69	2,543,300	62	1,279,500	41
November,	74,038,800	98	5,514,300	63	2,391,300	46	2,892,000	65	2,628,300	69	2,579,700	62	1,276,500	41
December,	76,691,000	102	5,719,200	65	2,230,900	45	2,853,900	64	2,706,100	71	2,318,800	56	1,231,400	39
For the year,	77,651,800	104	5,807,100	67	2,243,000	46	2,901,400	66	2,569,100	68	2,511,800	61	1,245,200	40

TABLE No. 25.—*Average Daily Consumption of Water in Cities and Towns, etc.—Continued.*

City or town, Population,	Month.	Melrose.		Watertown.		Arlington.		Milton.		Winthrop.	
		Per Day.		Per Day.		GALLONS.		GALLONS.		GALLONS.	
		Per Capita.	Per Capita.	Per Capita.	Per Capita.	Per Day.	GALLONS.	Per Day.	GALLONS.	Per Day.	GALLONS.
January,	.	978,000	58	1,452,200	58	1,087,900	67	756,900	51	294,000	34
February,	.	886,200	53	1,425,500	57	1,011,500	62	738,800	50	300,000	35
March,	.	887,400	51	1,311,600	52	1,053,200	64	730,800	49	303,100	35
April,	.	839,700	50	1,394,700	54	1,066,800	65	780,900	52	349,300	41
May,	.	867,000	51	1,440,600	57	1,082,100	66	859,400	58	350,200	44
June,	.	970,000	57	1,566,000	62	1,171,700	71	1,121,200	76	408,200	47
July,	.	827,100	49	1,718,500	67	1,060,000	64	901,700	60	317,800	37
August,	.	780,600	46	1,735,800	68	954,100	57	731,400	48	312,400	36
September,	.	873,600	51	1,651,000	64	1,024,200	61	1,032,800	70	358,000	41
October,	.	843,700	50	1,424,500	55	931,300	55	758,500	50	370,300	43
November,	.	775,300	45	1,359,400	52	932,800	55	739,500	48	347,700	40
December,	.	714,800	42	1,362,100	53	929,000	55	727,700	48	325,200	37
For the year,	.	851,500	50	1,484,800	58	1,025,200	62	835,300	55	338,900	39

TABLE No. 25.—Average Daily Consumption of Water in Cities and Towns, etc.—Concluded.

Month.	Per Day.	Per Capita.	METROPOLITAN DISTRICT.								
									STONHAM.		
									BELMONT.		
January,	51	378,300	48	342,400	62	66,200	48	332,700	46	109,297,100	96
February,	48	369,200	46	366,300	59	324,700	59	68,900	50	321,600	44
March,	49	388,700	48	389,900	60	330,300	60	74,200	53	345,600	47
April,	51	379,300	50	406,300	50	338,600	61	100,900	73	376,100	51
May,	52	390,600	56	456,500	65	360,500	65	139,600	100	463,400	63
June,	54	407,900	66	536,700	81	452,600	81	323,500	231	610,400	83
July,	50	374,400	50	410,700	50	350,800	63	350,300	250	559,700	76
August,	46	343,900	46	395,900	48	351,600	63	282,700	202	570,000	77
September,	48	361,800	48	549,300	67	390,900	70	267,800	190	549,300	74
October,	48	364,500	50	413,100	50	381,200	68	125,300	89	398,300	54
November,	50	373,500	50	420,300	51	345,500	63	74,900	53	355,600	48
December,	51	382,700	46	382,300	46	334,100	60	63,700	45	347,300	46
For the year,	60	373,700	52	425,400	64	358,700	64	161,900	116	436,400	59
										101,941,400	88

TABLE No. 26.—(Pump Basis.) Consumption of Water in the Metropolitan Water District, as constituted in the Year 1915, and
a Small Section of the Town of Saugus, from 1893 to 1915.

(Gallons per day.)

Month.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.
January,	75,299,000	67,506,000	68,925,000	82,046,000	85,366,000	82,580,000	96,442,000	100,055,000	111,275,000	118,425,000	125,176,000	137,771,000
February,	71,900,000	68,944,000	80,375,000	87,021,000	83,967,000	87,475,000	103,454,000	98,945,000	117,497,000	117,268,000	122,728,000	143,222,000
March,	67,638,000	62,710,000	69,543,000	86,111,000	82,751,000	88,483,000	90,300,000	97,753,000	105,569,000	108,461,000	111,977,000	123,334,000
April,	62,309,000	57,715,000	62,909,000	77,529,000	79,914,000	76,674,000	86,911,000	89,497,000	93,317,000	103,163,000	107,179,000	108,638,000
May,	61,025,000	60,376,000	65,194,000	73,402,000	76,772,000	76,677,000	89,448,000	87,780,000	95,567,000	106,692,000	111,589,000	111,715,000
June,	63,374,000	68,329,000	69,905,000	77,639,000	77,942,000	83,463,000	97,691,000	98,581,000	103,420,000	110,002,000	105,500,000	111,209,000
July,	69,343,000	73,642,000	69,867,000	80,000,000	85,525,000	88,228,000	96,821,000	107,786,000	106,905,000	108,340,000	107,582,000	113,584,000
August,	66,983,000	67,985,000	72,233,000	78,337,000	84,103,000	87,558,000	92,072,000	102,815,000	107,045,000	103,570,000	112,836,000	
September,	64,854,000	67,137,000	73,724,000	74,160,000	84,296,000	88,298,000	91,478,000	103,612,000	102,103,000	107,752,000	108,772,000	114,188,000
October,	63,770,000	62,735,000	67,028,000	71,762,000	79,551,000	81,770,000	89,580,000	98,358,000	103,389,000	106,560,000	103,602,000	108,290,000
November,	61,204,000	62,231,000	64,581,000	71,933,000	72,177,000	86,719,000	93,648,000	101,324,000	106,175,000	103,477,000	108,054,000	
December,	66,700,000	65,108,000	70,443,000	79,449,000	76,594,000	86,355,000	85,940,000	97,944,000	113,268,000	125,434,000	114,721,000	125,119,000
Average,	66,165,000	65,382,000	69,489,000	78,336,000	80,793,000	83,051,000	92,111,000	98,089,000	104,845,000	110,345,000	110,277,000	118,114,000
Population,	724,180	744,720	765,420	787,980	810,340	832,720	855,250	877,700	892,740	907,780	922,820	937,960
Per capita,	91.4	87.3	90.8	99.5	99.7	100.4	107.7	111.7	117.2	121.6	119.5	126.9

See note at end of this table.

TABLE No. 26.—(Pump Basis.) Consumption of Water, etc.—Concluded.

[Gallons per day.]

MONTH.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.
January,	130,878,000	126,093,000	137,720,000	132,376,000	133,275,000	127,568,000	123,281,000	137,277,000	113,489,000	117,387,000	109,689,000
February,	140,585,000	130,766,000	150,822,000	146,194,000	130,763,000	131,063,000	124,356,000	141,440,000	120,713,000	127,083,000	108,361,000
March,	120,379,000	123,570,000	134,202,000	128,884,000	126,842,000	117,078,000	116,669,000	122,304,000	107,571,000	110,106,000	102,241,000
April,	111,898,000	118,428,000	121,556,000	128,926,000	125,335,000	112,775,000	111,658,000	113,308,000	104,086,000	103,609,000	98,085,000
May,	115,894,000	122,404,000	123,562,000	131,040,000	123,305,000	112,073,000	118,095,000	114,546,000	104,311,000	105,821,000	98,940,000
June,	117,441,000	121,382,000	125,623,000	139,843,000	126,179,000	114,082,000	114,145,000	118,783,000	108,193,000	114,165,000	104,252,000
July,	124,769,000	118,726,000	128,779,000	138,232,000	126,765,000	122,745,000	123,052,000	120,261,000	112,084,000	106,233,000	101,074,000
August,	121,158,000	120,591,000	131,098,000	128,073,000	121,781,000	118,373,000	111,091,000	112,968,000	108,660,000	105,786,000	101,331,000
September,	120,103,000	121,685,000	124,751,000	129,972,000	118,086,000	112,434,000	108,726,000	112,352,000	108,449,000	109,873,000	108,043,000
October,	118,301,000	116,561,000	124,051,000	124,159,000	115,939,000	112,332,000	108,873,000	110,220,000	103,756,000	105,241,000	103,622,000
November,	116,693,000	113,746,000	119,637,000	117,119,000	111,664,000	107,528,000	105,372,000	108,289,000	101,441,000	101,228,000	101,474,000
December,	122,986,000	130,945,000	122,407,000	124,468,000	115,733,000	121,994,000	104,592,000	110,114,000	102,480,000	108,741,000	102,074,000
Average,	121,671,000	122,985,000	128,561,000	130,712,000	123,851,000	117,458,000	113,951,000	118,546,000	107,466,000	109,489,000	103,297,000
Population,	955,920	981,720	1,007,520	1,025,890	1,051,420	1,077,000	1,108,290	1,129,500	1,155,710	1,181,920	1,208,160
Per capita,	127.3	124.4	127.4	116.8	109.1	103.3	105.0	93.0	92.6	85.4	

This table includes the water consumed in the cities and towns enumerated in Table No. 25, together with the water consumed in Newton, which is included in the Metropolitan Water District but has not been supplied from the Metropolitan Works, and a small section of the town of Saugus.

On account of revision of populations, some of the population and per capita figures in this report differ from those published in the corresponding table in previous annual reports.

TABLE No. 27.—Chemical Examinations of Water from the Wachusett Reservoir, Clinton.
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.	COLOR.	ODOR.	Residue on Evapo-		Ammonia.	NITROGEN AS	OXYGEN consumed.	Hydrogen.	
					Total.	Loss on Evapo-					
					Dissolved.	Suspended.					
121494	Jan. 5	None.	V. slight.	None.	0.95	0.024	0.014	0.110	0.000	20	
121736	Jan. 19	None.	V. slight.	Faintly vegetable.	2.75	0.026	0.012	0.018	0.000	22	
121969	Feb. 2	None.	V. slight.	V. faintly vegetable.	3.30	0.030	0.018	0.016	0.000	27	
122191	Feb. 16	V. slight.	V. slight.	Faintly cucumber.	3.20	0.036	0.012	0.018	0.000	28	
122441	Mar. 2	V. slight.	V. slight.	V. faintly vegetable.	3.20	0.036	0.018	0.014	0.000	22	
122734	Mar. 16	V. slight.	V. slight.	Faintly cucumber syn-	3.50	0.030	0.014	0.018	0.000	27	
123070	Apr. 6	V. slight.	Slight.	Faintly vegetable cucum-	3.00	0.030	0.018	0.012	0.000	21	
123280	Apr. 20	V. slight.	V. slight.	Faintly vegetable.	3.00	0.016	0.014	0.016	0.000	26	
123544	May 4	V. slight.	V. slight.	V. faintly vegetable.	2.50	0.020	0.016	0.016	0.000	24	
123826	May 18	V. slight.	V. slight.	V. faintly vegetable.	3.70	0.020	0.016	0.014	0.000	27	
124054	June 1	V. slight.	V. slight.	Faintly vegetable.	3.35	0.022	0.018	0.016	0.000	20	
124344	June 16	V. slight.	V. slight.	Faintly vegetable.	3.15	0.022	0.018	0.014	0.000	18	
124661	July 6	V. slight.	V. slight.	Faintly vegetable.	3.10	0.014	0.012	0.010	0.000	19	
125048	July 20	V. slight.	V. slight.	Faintly vegetable.	3.05	0.012	0.012	0.008	0.000	24	
125416	Aug. 3	V. slight.	V. slight.	V. faintly vegetable.	3.05	0.016	0.012	0.010	0.000	20	
125771	Aug. 17	V. slight.	V. slight.	Faintly vegetable and sweetish.	-	0.0054	0.012	0.013	0.014	13	
126233	Sept. 7	V. slight.	None.	-	-	0.018	0.012	0.018	0.034	-	
126380	Sept. 14	V. slight.	V. slight.	Faintly vegetable.	4.00	0.020	0.022	0.150	0.042	31	
126808	Oct. 5	V. slight.	V. slight.	V. faintly vegetable.	3.15	0.023	0.018	0.016	0.020	34	
127129	Oct. 19	None.	V. slight.	Faintly vegetable.	3.35	0.020	0.012	0.012	0.020	29	
127469	Nov. 2	V. slight.	V. slight.	Faintly vegetable.	3.00	0.016	0.016	0.016	0.028	35	
127758	Nov. 16	None.	V. slight.	V. faintly vegetable.	3.20	0.018	0.014	0.016	0.064	35	
128177	Dec. 7	V. slight.	V. slight.	None.	3.50	0.050	0.050	0.049	0.118	-	
128363	Dec. 21	V. slight.	V. slight.	Faintly vegetable.	3.20	0.036	0.016	0.012	0.012	-	
A.v.		
								3.26		1.06	
								.0024		.0023	
								.0143		.0120	

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TABLE No. 28.—*Chemical Examinations of Water from the Sudbury Reservoir.*
 [Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.		OZONE.		AMMONIA.		NITROGEN.		OXYGEN consumed. Hardness.	
		Turbidity.	Color.	Cold.	Hot.	ALKALINITY.		NITRATES.			
						Total.	Loss on Evapo- ration.	Dissolved.	Suspended.		
121438	Jan. 4	V. slight.	V. slight. also yellow. V. slight. also yellow.	.11	V. faintly vegetable. Faintly unpleasant.	3.50	0.36	.0014	.0162	.0136 .0026	
121954	Feb. 1	V. slight.	V. slight. also yellow. V. slight. also yellow.	.09	Faintly vegetable. Faintly unpleasant. and fatty.	3.15	0.30	.0020	.0218	.0140 .0073	
122114	Mar. 2	V. slight.	V. slight. V. slight.	.20	Faintly vegetable. Faintly cucumber.	3.85	1.15	.0016	.0184	.0128 .0006	
123035	Apr. 5	V. slight.	V. slight.	.19	Faintly cucumber.	3.60	1.00	.0024	.0184	.0140 .0044	
123512	May 3	V. slight.	Slight.	.12	Faintly vegetable. Faintly vegetable.	4.20	1.25	.0060	.0216	.0206 .0010	
124040	June 1	V. slight.	V. slight.	.13	Faintly vegetable and sweetish. Faintly unpleasant.	4.65	1.40	.0020	.0174	.0132 .0043	
124669	July 6	V. slight.	V. slight.	.10	Faintly unpleasant.	4.75	1.30	.0019	.0186	.0124 .0063	
125341	Aug. 2	Slight.	Slight.	.15	V. faintly vegetable. Faintly vegetable.	-	-	.0032	.0236	.0142 .0084	
126123	Sept. 1	Slight.	Slight.	.22	Faintly vegetable. Faintly vegetable.	-	-	.0052	.0232	.0122 .0020	
126735	Oct. 5	V. slight.	Slight.	.12	Faintly vegetable. V. faintly vegetable.	3.90	1.40	.0028	.0210	.0173 .0053	
127125	Nov. 1	V. slight.	V. slight.	.10	V. faintly vegetable. Faintly unpleasant.	3.85	1.05	.0024	.0216	.0160 .0056	
128137	Dec. 6	V. slight.	V. slight.	.10	Faintly unpleasant.	3.45	1.90	.0029	.0166	.0153 .0016	
Av.				.14		3.89	1.13	.0026	.0164	.0154 .0040	

TABLE No. 29.—*Chemical Examinations of Water from Spot Pond, Stoneham.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.		ODOR.		Residue on Evapo-ration.		AMMONIA.		NITROGEN AS		Oxygen consumed.	Hardness.		
		Turbidity.	Color.	Cold.	Hot.	ALUMINUM.		Chlorine.		Nitrites.					
						Total.	Froth.	Suspended.	Dissolved.	Loss on Ignition.	Nitrate.				
121832	Jan. 6	None.	V. slight.	.05	V. faintly vegetable.	3.90	1.10	.0012	.0146	.0128	.43	.0010	.0000	.22	1.4
122639	Feb. 8	V. slight.	V. slight.	.03	V. faintly vegetable and unpleasant.	3.25	0.80	.0044	.0144	.0130	.41	.0000	.0000	.25	1.3
122631	Mar. 8	V. slight.	V. slight.	.09	Faintly overnumbered.	3.50	0.90	.0010	.0158	.0118	.40	.0000	.0000	.16	1.4
123077	Apr. 6	V. slight.	V. slight.	.03	Faintly unpleasant and fishy.	3.60	1.00	.0006	.0172	.0146	.48	.0000	.0001	.24	1.3
123508	May 3	V. slight.	Slight.	.10	Distinctly unpleasant decaying organisms.	3.85	1.00	.0024	.0200	.0158	.42	.0000	.0000	.19	1.4
124030	June 1	V. slight.	Slight.	.10	Decidedly unpleasant decaying organisms.	3.55	1.25	.0008	.0184	.0164	.40	.0000	.0000	.20	1.3
124443	July 6	V. slight.	V. slight.	.05	Faintly vegetable.	4.05	1.25	.0010	.0140	.0124	.0116	.0020	.0000	.30	1.3
125430	Aug. 4	V. slight.	V. slight.	.06	None.	—	—	.0028	.0156	.0126	.0030	.41	—	—	1.7
126115	Aug. 31	V. slight.	V. slight.	.09	Faintly vegetable and unpleasant.	—	—	.0020	.0152	.0144	.0038	.30	—	—	1.4
126639	Oct. 11	V. slight.	V. slight.	.06	V. faintly vegetable.	4.05	1.00	.0042	.0218	.0168	.0060	.35	—	—	1.4
127602	Nov. 8	V. slight.	V. slight.	.02	V. faintly vegetable.	3.85	1.00	.0072	.0172	.0142	.0030	.42	—	—	1.3
128395	Dec. 7	None.	V. slight.	.01	V. faintly vegetable.	3.70	1.25	.0022	.0186	.0150	.0036	.39	—	—	1.4
Av.	.....	.....	.....	.06	.....	3.73	1.07	.0025	.0169	.0141	.0028	.41	—	—	1.4

TABLE No. 30.—*Chemical Examinations of Water from Lake Cochituate.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.	ODOR.	COLOR.	Sediment.	Hot.	Residue on Evapo- ration.		AMMONIA.		NITROGEN AS Nitrites. Nitrate.		Oxygen consumed. Hardness.		
							Total.	Loss on Evaporation.	ALBUMINOID.		Total.	Suspended.			
									Total.	Free.					
121335	Jan. 4	V. slight.	V. faintly vegetable.	.30	Faintly vegetable.	Faintly vegetable.	6.00	1.45	.0202	.0236	.0192	.0044	.60	.0010 .0001 .40 .2.5	
121383	Feb. 2	V. slight.	V. faintly vegetable.	.26	Faintly vegetable.	Distinctly vegetable.	6.70	1.55	.0074	.0250	.0192	.0038	.63	.0030 .0001 .49 .2.5	
122220	Mar. 1	V. slight.	Slight.	.30	Faintly vegetable.	Distinctly vegetable.	6.45	2.00	.0016	.0178	.0146	.0032	.60	.0060 .0000 .41 .2.5	
123041	Apr. 5	V. slight.	Slight.	.32	Faintly vegetable and faintly unpleasant.	Distinctly vegetable and faintly unpleasant.	5.85	1.65	.0020	.0294	.0200	.0064	.66	.0040 .0002 .56 .2.3	
123324	May 3	V. slight.	Slight.	.19	Faintly vegetable.	Distinctly vegetable.	6.50	1.80	.0046	.0240	.0178	.0032	.70	.0040 .0000 .38 .2.5	
124067	June 2	Slight.	Slight.	.16	Faintly vegetable and sweetish.	Distinctly vegetable and sweetish.	6.00	1.65	.0008	.0248	.0178	.0070	.70	.0010 .0000 .30 .2.2	
124700	July 7	V. slight.	Slight.	.10	Faintly vegetable.	Distinctly vegetable.	6.00	1.70	.0008	.0190	.0148	.0043	.64	.0020 .0000 .34 .2.3	
125405	Aug. 4	Slight.	Slight.	.15	V. faintly vegetable.	Faintly vegetable.	—	—	.0023	.0184	.0166	.0018	.73	—	— .2.3
126120	Sept. 1	V. slight.	Slight.	.13	V. faintly vegetable.	Faintly vegetable.	—	—	.0020	.0246	.0194	.0052	.69	—	— .2.2
126374	Oct. 6	V. slight.	Slight.	.10	Faintly vegetable.	Distinctly vegetable.	5.35	1.60	.0056	.0254	.0212	.0042	.64	—	— .2.7
127115	Nov. 3	V. slight.	Slight.	.11	Faintly vegetable and earthy.	Distinctly vegetable and earthy.	6.10	1.75	.0104	.0266	.0204	.0053	.72	—	— .2.6
128192	Dec. 7	V. slight.	Slight.	.11	Faintly unpleasant.	Distinctly unpleasant.	6.20	1.85	.0156	.0258	.0182	.0076	.72	—	— .2.5
Av.18	6.12	1.70	.0061	.0235	.0183	.0052	.67	—	— .2.4

TABLE No. 31.—*Chemical Examinations of Water from a Tap at the State House, Boston.*

[Parts per 100,000.]

Number.	Date of Collection.	Twibidity.	Appearance.	Odor.		Residue on Evapo- ration.	AMMONIA.			Oxygen consumed. Hardness.	
				Color. Platinum Bromide.	Sediment Bromide.		Chlorine.				
							Total.	Dissolved.	Suspended.	Nitrites. as Nitrate.	
121430	Jan. 5	V. slight.	V. slight.	.10	V. faintly vegetable.	8.10	0.80	.0024	.012	.0024	24 .3
121940	Feb. 1	V. slight.	V. slight.	.12	Faintly vegetable.	3.65	0.80	.0024	.0120	.0010	24 1.3
122405	Mar. 2	V. slight.	V. slight.	.15	Faintly vegetable.	3.40	0.80	.0012	.0124	.0028	24 .26
123031	Apr. 5	V. slight.	V. slight.	.20	V. faintly vegetable.	3.85	1.40	.0020	.0154	.0146	25 1.4
123809	May 3	V. slight.	V. slight.	.13	Faintly vegetable.	4.00	1.10	.0024	.0182	.0158	25 1.4
124649	July 6	V. slight.	V. slight.	.10	V. faintly vegetable.	3.80	1.16	.0006	.0124	.0110	29 1.3
125519	Aug. 11	V. slight.	V. slight.	.22	V. faintly vegetable.	—	—	.0002	.0136	.0114	29 .29
126069	Aug. 30	V. slight.	V. slight.	.20	V. faintly vegetable.	—	—	.0006	.0178	.0132	29 .29
126756	Oct. 4	V. slight.	V. slight.	.22	Faintly vegetable.	—	—	.0016	.0198	.0160	29 .29
127455	Nov. 3	V. slight.	V. slight.	.15	V. faintly vegetable.	4.20	1.10	.0010	.0182	.0174	29 .29
128613	Dec. 28	V. slight.	Slight.	.13	V. faintly vegetable and unpleasant.	3.80	1.15	.0018	.0196	.0164	29 .29
Av.16	8.73	1.04	.0015	.0157	.0134	.0023 .38

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TABLE No. 32.—Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1916.
[Parts per 100,000.]

Locality.	Samples collected.	Residue on Evaporation.		AMMONIA.		Chloride.	Oxygen consumed.	Hardness.	
		Color.	Platinum Standard.	ALBUMINOID.					
				Total.	Loss on Digestion.	Dissolved.	Suspended.		
Quineopeck River, Holden,	•	.53	4.18	1.61	.0023	.0216	.0188	.0034	
Stillwater River, Sterling,	•	.43	3.77	1.41	.0025	.0184	.0153	.0045	
Wachusett Reservoir, West Boylston,	•	.28	3.68	1.35	.0024	.0177	.0147	.0030	
Wachusett Reservoir, Clinton, surface,	•	.11	3.26	1.06	.0024	.0142	.0120	.0028	
Wachusett Reservoir, Clinton, bottom,	•	.10	3.21	0.97	.0025	.0125	.0112	.0024	
Marlborough (Walker's Brook),	•	.70	19.83	5.09	.0025	.0176	.0169	.0034	
Marlborough Brook filter beds, effluent, ¹	•	.11	16.94	4.50	.0010	.0148	.0147	.0023	
Wachusett Aqueduct, Southborough,	•	.14	3.50	1.10	.0019	.0147	.0122	.0023	
Sudbury Reservoir, surface,	•	.14	3.89	1.13	.0026	.0146	.0154	.0030	
Sudbury Reservoir, bottom,	•	.14	3.12	1.12	.0034	.0173	.0139	.0026	
Framingham Reservoir No. 3, inlet,	•	.14	3.66	1.05	.0032	.0172	.0142	.0036	
Framingham Reservoir No. 3, near dam,	•	.14	3.70	1.17	.0037	.0200	.0159	.0041	
Hopkinton Reservoir, inlet,	•	2.12	7.92	4.10	.0045	.0216	.0147	.0059	
Hopkinton Reservoir, surface,	•	.65	4.20	1.64	.0033	.0256	.0226	.0031	
Hopkinton Reservoir, bottom,	•	.83	4.34	1.67	.0040	.0226	.0172	.0023	
Ashland Reservoir, inlet,	•	1.38	6.60	3.04	.0039	.0452	.0380	.0072	
Ashland Reservoir, surface,	•	.60	4.80	1.61	.0034	.0277	.0232	.0046	
Ashland Reservoir, bottom,	•	.64	4.32	1.71	.0035	.0244	.0211	.0038	
Framingham Reservoir No. 2, inlet,	•	.94	5.74	2.46	.0047	.0318	.0280	.0058	
Framingham Reservoir No. 2, near dam,	•	.94	5.64	2.49	.0058	.0319	.0269	.0050	
Lake Cochituate, surface,	•	.18	6.12	1.70	.0051	.0235	.0188	.0052	
Lake Cochituate, bottom,	•	.65	6.75	2.03	.0063	.0319	.0226	.0058	
Weston Reservoir, bottom,	•	.12	3.91	1.23	.0022	.0169	.0137	.0029	
Terminal chamber, Sudbury Aqueduct,	•	.15	3.77	1.15	.0021	.0170	.0137	.0031	
Spot Pond,	•	.06	3.73	1.07	.0025	.0169	.0141	.0028	
Tap in Revere,	•	.06	3.78	1.12	.0013	.0144	.0127	.0017	
Tap at State House, ¹	•	.16	3.73	1.04	.0015	.0157	.0124	.0028	
Tap at Quincy, ¹	•	.12	3.70	1.06	.0012	.0136	.0127	.0018	

¹ Averages for 7 months, January to July inclusive.² Average of 7 samples.³ Average of 11 samples.

TABLE No. 33.—*Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1915.*

[Parts per 100,000.]

YEAR.	COLOR.		RESIDUE ON EVAPORATION.		AMMONIA.			NITROGEN AS		OXYGEN CONSUMED.		
	Nessler Standard.	Platinum Standard.	Total.	Loss on Ignition.	ALBUMINOID.			Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	
					Free.	Total.	Dissolved.					
1892, . . .	.37	.37	4.70	1.67	.0007	.0168	.0138	.0030	.41	.0210	.0001	- 1.9
1893, . . .	.61	.53	4.54	1.84	.0010	.0174	.0147	.0027	.38	.0143	.0001	.60 1.8
1894, . . .	.69	.58	4.64	1.83	.0006	.0169	.0150	.0019	.41	.0106	.0001	.63 1.7
1895, . . .	.72	.59	4.90	2.02	.0006	.0197	.0175	.0022	.40	.0171	.0001	.69 0.7
1896, . . .	.49	.45	4.29	1.67	.0005	.0165	.0142	.0023	.37	.0155	.0001	.56 1.4
1897, . . .	.65	.55	4.82	1.84	.0009	.0193	.0177	.0016	.40	.0137	.0001	.64 1.6
1898, . . .	.41	.40	4.19	1.60	.0008	.0152	.0138	.0016	.29	.0097	.0001	.44 1.4
1899, . . .	.23	.28	3.70	1.30	.0006	.0136	.0122	.0014	.24	.0137	.0001	.35 1.1
1900, . . .	.24	.29	3.80	1.20	.0012	.0157	.0139	.0018	.25	.0076	.0001	.33 1.3
1901, . . .	.24	.29	4.43	1.64	.0013	.0158	.0142	.0016	.30	.0173	.0001	.42 1.7
1902, . . .	.26	.30	3.93	1.56	.0016	.0139	.0119	.0020	.29	.0092	.0000	.40 1.3
1903, . . .	.25	.29	3.98	1.50	.0013	.0125	.0110	.0015	.30	.0142	.0001	.39 1.5
1904, . . .	-	.23	3.93	1.59	.0023	.0139	.0121	.0018	.34	.0110	.0001	.37 1.5
1905, . . .	-	.24	3.86	1.59	.0020	.0145	.0124	.0021	.35	.0083	.0001	.35 1.4
1906, . . .	-	.24	3.86	1.39	.0018	.0159	.0134	.0025	.34	.0054	.0001	.36 1.3
1907, . . .	-	.22	3.83	1.40	.0013	.0129	.0109	.0020	.33	.0068	.0001	.32 1.3
1908, . . .	-	.19	3.50	1.35	.0011	.0115	.0092	.0024	.33	.0092	.0001	.26 1.2
1909, . . .	-	.18	3.46	1.43	.0011	.0128	.0103	.0025	.28	.0034	.0000	.25 1.3
1910, . . .	-	.14	3.05	1.24	.0013	.0118	.0102	.0016	.28	.0030	.0000	.22 1.1
1911, . . .	-	.25	4.18	1.66	.0015	.0156	.0128	.0029	.38	.0029	.0000	.33 1.4
1912, . . .	-	.17	3.86	1.23	.0018	.0154	.0119	.0034	.36	.0062	.0000	.29 1.7
1913, . . .	-	.13	3.96	1.15	.0014	.0150	.0120	.0026	.35	.0064	.0000	.26 1.5
1914, . . .	-	.14	4.12	1.19	.0014	.0138	.0116	.0022	.39	.0076	.0000	.25 1.4
1915, . . .	-	.16	3.73	1.04	.0015	.0157	.0134	.0023	.38	.0048 ¹	.0000 ¹	.25 ¹ 1.4

¹ Averages for 7 months, January to July inclusive.

TABLE No. 34.—*Microscopic Organisms in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1915 inclusive.*

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WAGENKNECHT RESERVOIR.	SUDSBURY RESERVOIR.		LAKE COCHETUAN.		FRAMINGHAM RESERVOIR. No. 2.		ASHLAND RESERVOIR.		HOPKINTON RESERVOIR.		WHITEHORN RESERVOIR.	
		Surface.	Bottom.	Surface.	Bottom.	Surface.	Bottom.	Mid-depth.	Surface.	Surface.	Surface.	Surface.	Surface.
1898,	.	-	-	354	149	830	696	245	263	94	960		
1899,	.	-	-	470	253	905	644	440	218	357	715	393	
1900,	.	-	-	498	361	1,753	1,071	645	305	390	980	497	
1901,	.	-	-	337	225	922	702	336	149	244	460	705	
1902,	.	-	-	590	402	1,071	720	627	204	550	588	198	
1903,	.	-	-	549	388	931	705	459	160	323	281	327	
1904,	.	-	-	313	-	376	663	542	475	174	153	106	375
1905,	.	-	-	769	592	644	502	1,255	503	535	158	240	147
1906,	.	-	-	446	273	953	714	1,407	1,143	692	226	431	475
1907,	.	-	-	425	312	513	419	1,123	1,260	413	305	378	336
1908,	.	-	-	731	466	850	885	1,559	1,241	932	725	690	516
1909,	.	-	-	2,151	1,927	2,474	2,513	1,142	1,188	2,372	610	603	294
1910,	.	-	-	480	328	464	556	928	1,083	455	426	387	164
1911,	.	-	-	649	368	990	988	1,942	2,216	1,140	378	592	487
1912,	.	-	-	595	368	939	582	4,682	7,873	888	241	665	516
1913,	.	-	-	449	270	553	541	4,964	7,322	560	263	414	298
1914,	.	-	-	763	309	735	692	2,036	4,159	533	-	327	325
1915,	.	-	-	519	356	1,005	828	1,900	3,213	701	-	450	284

See note at end of this table.

TABLE No. 34.—*Microscopic Organisms in Water, etc.—Concluded.*

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WESTON RESERVOIR.	SPOT POND.	CHESTNUT HILL RESERVOIR.				TAPS.			
			Surface.	Inlet.	304	304	SOUTHERN COCHITuate AQUADuct.		NORTHERN COCHITuate AQUADuct.	
							MILFUGENT GATE-HOUSE.	No. 2.	MILFUGENT GATE-HOUSE.	No. 2.
1898,	-	-	495	-	544	304	230	-	-	-
1899,	-	-	1,129	359	922	329	192	201	-	-
1900,	-	-	573	568	1,139	897	468	452	-	-
1901,	-	-	628	344	697	413	243	280	-	-
1902,	-	-	581	563	937	525	367	451	-	-
1903,	-	-	650	450	860	435	286	398	-	-
1904,	-	-	465	405	838	472	303	470	274	189
1905,	-	-	609	551	904	554	528	671	363	288
1906,	-	-	783	671	631	1,042	721	550	533	423
1907,	-	-	443	650	349	909	419	312	427	205
1908,	-	-	979	741	783	1,073	689	666	696	443
1909,	-	-	2,399	1,079	1,999	632	1,859	1,913	1,059	1,313
1910,	-	-	625	623	457	-	445	447	421	221
1911,	-	-	934	748	700	1,382	954	778	735	349
1912,	-	-	1,117	716	856	8,887	919	1,035	967	412
1913,	-	-	585	607	585	2,822	890	531	410	237
1914,	-	-	767	648	492	-	540	608	549	249
1915,	-	-	725	656	643	-	601	597	631	262

NOTE.—A large growth of *Asterionella* originated in the Wachusett Reservoir in 1908, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE No. 35.—*Number of Bacteria per Cubic Centimeter in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1915, inclusive.*

[Averages of weekly determinations.]

YEAR.	CHESTNUT HILL RESERVOIR.			SOUTHERN SERVICE TAPS.	
	Sudbury Aqueduct Terminal Chamber.	Cochituate Aqueduct.	Effluent Gate-house No. 2.	Low Service, 180 Boylston Street.	High Service, 1 Ashburton Place.
1898,	207	145	111	96	-
1899,	224	104	217	117	123
1900,	248	113	256	188	181
1901,	225	149	169	162	168
1902,	203	168	121	164	246
1903,	76	120	96	126	243
1904,	347	172	220	176	355
1905,	495	396	489	231	442
1906,	231	145	246	154	261
1907,	147	246	118	130	176
1908,	162	138	137	136	148
1909,	198	229	119	150	195
1910,	216	-	180	178	213
1911,	205	204	151	175	197
1912,	429	450	227	249	259
1913,	123	243	157	119	140
1914,	238	-	252	174	220
1915,	163	-	128	117	134
Averages,	228	201	188	157	217

TABLE No. 36.—*Colors of Water from Various Parts of the Metropolitan Water Works in 1915. (Averages of Weekly Determinations.)*

[Platinum Standard.]

Month.	WACHUETT RESERVOIR.	SUDSBURY RESERVOIR.	FRANK INGRAM RIVER, No. 1.	LAKE COOTERVILLE.	Chestnut Hill Reservoir.	Spot Post.	Northern Survivor.	Southern Survivor.	Top at 180 Boylston (Low Street, Boston) (Low Belt-line). Top at 180 Boylston (High Belt-line).	
									Mid-depth.	Bottom.
January,	.	.	12	13	14	15	16	15	15	15
February,	.	.	15	14	20	19	18	16	15	16
March,	.	.	16	16	34	33	22	22	23	20
April,	.	.	16	16	36	47	41	21	20	21
May,	.	.	15	15	55	44	18	18	18	19
June,	.	.	15	15	22	44	32	18	19	19
July,	.	.	15	16	33	52	19	20	20	17
August,	.	.	15	16	17	26	53	24	24	18
September,	.	.	17	17	16	17	47	46	40	33
October,	.	.	16	17	16	17	46	20	19	17
November,	.	.	12	13	12	14	55	40	15	16
December,	.	.	12	12	12	43	49	16	15	15
Averages,	.	.	15	15	31	53	45	19	19	18
								10	10	10
								18	11	18
									18	18

¹ The colors given in this column represent the combined colors of the waters of the four principal feeders. The color of each is determined monthly, and due weight is given in combining the results to the sizes of the streams.

TABLE No. 37.—Temperatures of Water from Various Parts of the Metropolitan Water Works in 1915. (Averages of Weekly Determinations.)

[The temperatures are taken at the same places and times as the samples for microscopic examination; the depth given for each reservoir is the depth from high-water mark.]

[Degrees Fahrenheit.]

MONTH.	WAGHORN ¹ RESERVOIR (DEPTH AT PLACE OF OBSERVATION 107 FEET).	SUBBURY ¹ RESERVOIR (DEPTH AT PLACE OF OBSERVATION 64.5 FEET).	WAGHORN AND AQUA- DUCT.	FRANKINGHAM ¹ RESERVOIR NO. 3 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET).	LAKE COOPERATIVE ¹ (DEPTH AT PLACE OF OBSERVATION 62.0 FEET).		SPOT POND ¹ (DEPTH AT PLACE OF OBSERVATION 28.0 FEET).		SOUTHERN SERVICE.	
					MID-DEPTH.	BOTTOM.	MID-DEPTH.	BOTTOM.	MID-DEPTH.	BOTTOM.
JANUARY,	34.0	34.3	41.0	35.4	36.3	37.8	36.3	37.5	36.7	36.7
February,	35.0	35.6	36.0	35.3	37.3	36.5	37.0	37.3	37.3	37.3
March,	36.1	36.8	37.2	37.7	38.3	38.0	38.7	38.7	39.5	39.0
April,	42.5	40.3	43.2	48.4	44.5	49.5	45.9	40.0	40.4	41.3
May,	42.9	40.0	44.7	51.5	51.5	55.4	50.5	49.5	49.5	49.5
June,	53.5	57.5	49.3	61.7	61.7	67.9	65.1	52.3	48.5	55.0
July,	71.9	64.8	61.6	73.9	69.0	73.7	71.1	54.5	49.5	65.7
August,	70.5	63.5	62.8	72.8	69.3	65.5	73.9	72.7	72.3	72.3
September,	69.1	63.0	63.5	70.1	69.5	68.0	65.0	50.5	50.5	69.3
October,	58.3	58.9	56.3	57.3	58.0	65.8	67.5	58.0	58.0	60.0
November,	48.8	48.8	48.3	47.0	46.5	42.0	43.9	44.3	45.0	47.2
December,	38.0	36.9	36.4	35.5	35.0	37.3	24.5	24.0	26.5	30.0
Averages,	51.8	49.1	46.3	53.3	52.4	52.2	49.4	52.9	54.1	54.5

¹ Surface temperatures are averages of weekly determinations. Mid-depth and bottom temperatures are averages of biweekly determinations.

TABLE No. 38.—*Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1915.*

[Degrees Fahrenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.			FRAMINGHAM.			CLINTON.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
January,	59	1	31.0	59	-1	29.3	57	0	27.1
February,	59	5	32.3	55	1	31.0	57	3	28.6
March,	58	12	34.7	58	10	33.8	59	11	33.7
April,	84	23	50.3	85	20	50.4	85	24	49.2
May,	79	34	55.8	77	34	55.5	75	30	55.4
June,	89	40	64.3	89	36	64.3	-	38	-
July,	89	51	70.2	88	49	69.8	88	52	68.4
August,	88	48	68.5	86	45	67.2	83	46	65.9
September,	94	38	65.6	92	37	65.2	87	38	64.5
October,	76	31	54.5	75	27	52.9	71	30	52.4
November,	70	25	48.2	69	23	49.9	66	24	41.4
December,	62	10	31.5	55	2	29.1	50	11	29.7
Averages,	-	-	50.2	-	-	49.1	-	-	-

TABLE No. 39.—Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewage Board, and Number of Valves set in Same, Dec. 31, 1915.

	Diameters or Press. in Inches.												Total.			
	60	48	42	40	36	30	24	20	16	14	12	10				
Total length owned and operated Dec. 31, 1914	29,334 ¹	211,090	9,810	6,989	61,163	49,087 ²	53,440	76,090	67,890	26	26,490	3,786	1,578	963	8	629,480
Gate valves in same,	3	54	1	2	51	41	57	54	70	1	106	18	22	-	-	506
Air valves in same,	25	124	3	3	43	20	40	45	33	-	10	1	-	-	-	347
Length laid or relaid during 1915 (feet),	14,342	-	-	-	623 ³	-	3,206	-	62	-	-	-	23	25	18,261	
Gate valves in same,	2	-	-	-	2	-	2	-	2	-	-	-	1	1	10	10
Air valves in same,	26	-	2	-	1	-	4	-	-	-	-	-	-	-	33	
Length abandoned during 1915 (feet),	-	-	-	-	34	-	1,297	-	115	-	-	-	-	-	1,446	
Gate valves in same,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Air valves in same,	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	
Length owned and operated Dec. 31, 1915	43,676 ¹	211,090	9,810	6,989	61,753	49,087 ²	56,349	76,090	67,777	26	26,490	3,786	1,578	965	33	645,415 ⁴
Gate valves in same,	5	64	1	2	53	41	59	54	81	1	106	18	22	1	516	
Air valves in same,	51	124	5	3	44	20	42	45	33	-	10	1	-	-	378	

¹ Includes 2,035 feet of 76-inch concrete-lined pressure tunnel and 863 feet of 76-inch cast-iron pipe.

² Includes 15,566 feet of 36-inch mortar-lined and covered wrought-iron pipe.

³ Includes 461 feet acquired from city of Boston.

⁴ 129.24 miles.

TABLE No. 40.—Statement of Cast-iron Hydrant, Blow-off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1915.

	Diameter of Pipes in Inches.						Total.
	24	26	16	12	10	8	
Total length in use Dec. 31, 1914 (feet),	352	292	3,093	6,455	176	350	3,452
Valves in same,	-	-	30	104	2	4	79
Length laid or relaid in 1915 (feet),	-	-	28	288	-	151	43
Valves in same,	-	-	-	2	-	4	43
Length abandoned in 1915 (feet),	-	-	-	38	-	-	23
Valves in same,	-	-	-	-	-	-	1
Total length in use Dec. 31, 1915 (feet),	352	292	3,121	6,635	176	501	3,472
Valves in same,	-	-	30	106	2	8	80

¹ 3.04 miles.

METROPOLITAN WATER

[Pub. Doc.]

TABLE No. 41.—Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1916.

By WHOM OWNED.	INCHES.														TOTALS.							
	60	48	42	40	36	30	28	24	20	18	16	14	12	10	8	7	6	4	Feet.	Miles.		
Metropolitan Water Works.	43,676	211,098	9,810	6,989	61,762	49,687	-	36,349	76,069	-	67,777	26	-	26,499	3,798	1,878	-	986	33	645,415	122.24	
Boston,	-	10,637	15,476	16,105	37,128	88,337	244	75,562	87,611	-	25,200	5,021	-	1,399,840	325,612	780,246	-	1,271,863	108,865	4,494,567	849.35	
Somerville,	-	-	-	-	-	-	-	-	3,721	367	4,021	7,950	-	88,963	86,718	104,380	-	213,904	22,045	503,799	95.42	
Maldan,	-	-	-	-	-	-	-	-	-	-	2,735	9,165	-	75,636	31,372	80,178	-	218,020	69,152	476,147	90.18	
Chelsea,	-	-	-	-	-	-	-	-	-	-	4,176	-	-	5,479	30,826	29,632	-	141,806	6,985	228,600	42.30	
Everett,	-	-	-	-	-	-	-	-	-	-	4,294	2,900	-	6,094	42,320	26,258	-	144,251	30,000	265,090	50.21	
Quincy,	-	-	-	-	-	-	-	-	-	-	2,479	-	-	29,125	42,882	123,118	984	336,484	97,850	685,014	129.74	
Medford,	-	-	-	-	-	-	-	-	-	-	673	-	-	30,226	38,900	91,272	-	148,483	28,913	354,740	67.19	
Melrose,	-	-	-	-	-	-	-	-	-	-	5,223	2,920	-	22,801	19,846	25,720	-	146,366	58,922	279,801	62.99	
Revere, ¹	-	-	-	-	-	-	-	-	-	-	28,800	5,758	1,200	20,900	26,017	31,298	-	98,450	72,285	279,778	62.99	
Watertown,	-	-	-	-	-	-	-	-	-	-	400	11,877	-	5,959	10,727	21,637	-	138,565	12,906	201,722	38.20	
Arlington,	-	-	-	-	-	-	-	-	-	-	-	-	-	24,136	28,912	39,474	-	130,708	15,911	238,138	45.10	
Milton,	-	-	-	-	-	-	-	-	-	-	-	-	-	22,556	30,926	51,870	-	151,625	17,249	264,323	50.06	
Wintrop,	-	-	-	-	-	-	-	-	-	-	-	-	-	4,049	24,073	33,773	-	51,335	58,955	170,158	32.23	
Bostonham,	-	-	-	-	-	-	-	-	-	-	-	-	-	7,626	1,825	4,730	-	106,155	17,521	137,966	26.13	
Belmont,	-	-	-	-	-	-	-	-	-	-	-	-	-	5,714	16,954	24,654	-	107,510	200	165,101	29.38	
Lexington,	-	-	-	-	-	-	-	-	-	-	-	-	-	9,000	4,879	35,433	-	114,652	27,794	191,758	36.32	
Natick,	-	-	-	-	-	-	-	-	-	-	-	-	-	150	11,050	4,800	-	36,800	63,208	116,508	22.07	
Swampscott,	-	-	-	-	-	-	-	-	-	-	-	-	-	6,714	18,306	6,593	-	72,425	9,025	116,108	21.99	
Total feet,	-	43,676	221,736	25,286	23,094	98,880	139,024	244	163,398	173,453	267	395,646	65,419	1,200	1,790,794	774,581	984	3,650,449	699,547	9,794,795	-	
Total miles,	-	8.27	41.99	4.79	4.37	18.73	26.33	0.05	30.95	32.89	0.07	74.94	12.39	0.23	389.17	146.70	289.17	0.19	691.37	132.49	1,865.09	-

¹ Includes small portion of Saugus.

TABLE NO. 42.—Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1915, and the Number of Services and Meters installed during the Year 1915.

CITY OR TOWN.	Services.	Meters.	Fire Hydrants.	Services Installed.	Meters Installed.
Boston,	103,195	54,848	9,398	1,390	6,829
Somerville,	13,233	9,155	1,214	210	734
Malden,	8,055	7,896	565	127	93
Chelsea,	4,971	4,957	384	166	169
Everett,	5,893	2,947	581	128	343
Quincy,	9,315	8,248	1,078	408	197
Medford,	6,043	5,846	668	412	406
Melrose,	4,005	4,211	364	99	105
Revere, ¹	4,466	3,137	288	222	433
Watertown,	2,798	2,622	379	225	141
Arlington,	2,753	2,755	461	249	247
Milton,	1,867	1,926	420	110	110
Winthrop,	2,903	2,829	271	84	82
Stoneham,	1,613	1,589	155	35	110
Belmont,	1,430	1,430	236	100	100
Lexington,	1,156	1,063	184	45	118
Nahant,	730	468	101	77	90
Swampscott,	1,810	1,810	181	66	66
Totals,	176,236	117,537	16,928	4,143	10,373

¹ Includes small portion of Saugus.

TABLE No. 43.—Average Elevation of the Hydraulic Grade Line, in Feet, above Boston City Base for Each Month at Stations on Metropolitan Water Works during 1915.

		SOUTHERN HIGH SERVICE.											
		WATERTOWN WATER WORKS OFFICE, MAIN STREET.						BOSTON METRO- POLITAN WATER WORKS OFFICE, 1 ARBUCKLE PLACE.					
		CHELSEA COUNTY HOUSE.			MAULDEN WATER WORKS SHOP, GREEN STREET.			ALLSTON ENGINE HOUSE, BULFINCH STREET.			MEDFORD ! CITY HALL ANNEX, HIGH STREET.		
Low Service.		Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
1915.	Month.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
	January,	143	143	178	166	163	167	161	168	161	167	163	166
	February,	144	144	176	166	166	162	161	167	160	166	158	166
	March,	147	147	178	166	162	162	162	167	162	167	163	167
	April,	150	150	177	163	166	163	167	161	167	166	163	166
	May,	145	145	175	163	166	162	167	161	167	162	166	165
	June,	145	145	175	167	166	163	166	161	166	162	166	164
	July,	147	147	173	166	163	166	162	166	161	166	163	164
	August,	148	148	171	165	165	162	166	161	167	162	166	165
	September,	147	147	177	168	166	162	167	162	167	162	166	165
	October,	147	147	176	168	166	162	166	161	167	162	166	164
	November,	147	147	176	167	166	162	167	161	168	162	166	164
	December,	143	143	175	169	166	162	166	163	169	163	167	165
	Averages,	146	146	176	167	166	162	166	161	167	162	166	166

1 Medford City Hall after August 31.

TABLE No. 43.—Average Elevation of the Hydraulic Grade Line, in Feet, above Boston City Base, etc.—Concluded.

1915. MONTH.	SOUTHERN HIGH SERVICE — Concluded.				NORTHERN HIGH SERVICE.				NORTHERN EXTRA HIGH SERVICE.			
	BELMONT WATER WORKS SHOP, WAVER- LEY STREET.		FORBES HILL TOWER, QUINCY. ADAMS STREET.		SOMERVILLE PUMPING STA- TION, CEDAR STREET.		MAIDEN CITY HALL.		REVERE WATER WORKS OFFICE, BROADWAY.		LYNN ENGINE HOUSE UNION SQUARE.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January,	262	250	239	242	234	241	225	269	249	265	267	258
February,	262	249	251	240	242	235	241	225	269	249	270	266
March,	260	247	252	241	245	236	244	230	270	247	271	265
April,	259	245	251	240	245	236	244	230	269	249	270	266
May,	262	242	249	237	242	233	241	225	269	246	270	265
June,	261	238	249	237	240	229	240	223	268	242	269	263
July,	261	245	249	239	244	231	242	224	268	250	269	263
August,	261	248	248	239	245	235	244	227	267	250	268	264
September,	262	241	251	240	246	235	244	228	267	245	268	263
October,	262	247	251	243	246	237	245	230	267	245	270	264
November,	261	249	250	241	245	235	244	228	269	247	271	266
December,	261	250	251	243	245	236	244	230	270	250	271	266
Averages,	261	246	250	240	244	234	243	227	269	247	270	265

APPENDIX No. 4.**WATER WORKS STATISTICS FOR THE YEAR 1915.**

The Metropolitan Water Works supply the Metropolitan Water District which includes the following cities and towns:—

CITY OR TOWN.	Population, Census of 1915.	Estimated Population, July 1, 1915.
Boston,	745,439	748,890
Somerville,	86,854	87,320
Malden,	49,907	49,160
Chelsea,	43,426	43,750
Newton, ¹	43,113	43,280
Everett,	37,718	37,950
Quincy,	40,674	40,940
Medford,	30,509	30,820
Malrose,	16,880	16,960
Revere,	25,178	25,500
Watertown,	16,515	16,860
Arlington,	14,889	15,050
Milton,	8,600	8,650
Winthrop,	12,758	12,900
Stoneham,	7,489	7,510
Swampscott,	7,345	7,390
Lexington,	5,538	5,570
Belmont,	8,081	8,180
Nahant,	1,337	1,400
Total population of Metropolitan Water District,	1,201,300	1,207,880
Saugus, ²	280	280

¹ No water supplied during the year from Metropolitan Water Works.

² Only a small portion of Saugus was supplied with water.

*Pumping.**Chestnut Hill Pumping Station No. 1:*—

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used:— Bituminous: Beaver Run. Anthracite: buckwheat.

Price per gross ton in bins: bituminous \$4.14, buckwheat \$3.08. Average price per gross ton \$3.97. Per cent. ashes 12.3.

Chestnut Hill Pumping Station No. 2:—

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used:— Bituminous: Beaver Run and Alpha Special. Anthracite: buckwheat. Price per gross ton in bins: bituminous \$4.03, buckwheat \$2.92. Average price per gross ton \$3.80. Per cent. ashes 12.5.

Spot Pond Pumping Station:—

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used:— Bituminous: New River. Anthracite: screenings.

Price per gross ton in bins: bituminous \$5.06, screenings \$2.50. Average price per gross ton \$4.38. Per cent. ashes 11.8.

	CHESTNUT HILL PUMPING STATIONS.		
	No. 1.		No. 2.
	Engine No. 1.	Engine No. 4.	Engine No. 12.
Daily pumping capacity (gallons),	8,000,000	30,000,000	40,000,000
Coal consumed for year (pounds),	904,430	1,893,530	5,788,640
Cost of pumping, figured on pumping station expenses,	\$4,843.86	\$11,918.66	\$20,112.04
Total pumpage for year, corrected for slip (million gallons),	289.20	2,898.99	8,020.42
Average dynamic head (feet),	133.80	119.38	123.26
Gallons pumped per pound of coal,	319.76	1,531.00	1,489.20
Duty on basis of plunger displacement,	38,750.00	155,310.00	156,000,000
Cost per million gallons raised to reservoir,	\$16.7492	\$4.1113	\$2.3331
Cost per million gallons raised one foot, . . . . .	.1252	.0344	.0189

	CHESTNUT HILL PUMPING STATION NO. 2.	SPOT POND PUMPING STATION.
	Engines Nos. 5, 6 and 7.	Engines Nos. 8 and 9.
Daily pumping capacity (gallons),	105,000,000	30,000,000
Coal consumed for year (pounds),	4,527,085	2,209,787
Cost of pumping, figured on pumping station expenses,	\$30,164.26	\$14,525.60
Total pumpage for year, corrected for slip (million gallons),	12,922.06	2,473.99
Average dynamic head (feet),	40.34	127.87
Gallons pumped per pound of coal,	2,854.39	1,119.56
Duty on basis of plunger displacement,	97,890.00	121,670.00
Cost per million gallons raised to reservoir,	\$2.3343	\$5.8713
Cost per million gallons raised one foot, . . . . .	.0579	.0459

Consumption.

Estimated total population of the eighteen cities and towns supplied wholly or partially during the year 1915,	1,164,600
Total consumption (gallons), pump basis,	36,639,340,000
Average daily consumption (gallons), pump basis,	100,382,000
Gallons per day to each inhabitant, pump basis,	86.2

Distribution.

	Owned and operated by Metropolitan Water and Sewerage Board.	Total in District supplied by Metropolitan Water Works.
Kinds of pipe used,	- ¹	- ¹
Sizes,	60-4 inch.	60-4 inch.
Extensions, less length abandoned (miles),	3.19	41.14
Length in use (miles),	122.24	1,855.09
Stop-gates added,	10	-
Stop-gates now in use,	516	4,143
Service pipes added,	-	176,236
Service pipes now in use,	-	10,373
Meters added,	-	117,537
Meters now in use,	-	455
Fire hydrants added,	-	16,928
Fire hydrants now in use,	-	-

¹ Cast-iron, cement-lined wrought-iron, cement-lined steel and kalamine pipe.

APPENDIX No. 5.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

1. Number of Contract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Lowest.	5. Lowest.	
1 110 ¹	Part of Section 69, Station 0 to Station 23 + 0, New Mystic sewer, North Metropolitan System in Winchester.	7	\$34,975 00	\$33,360 00 ²	The Henry Spinach Contracting Co., Waterbury, Conn.
2 111 ¹	Part of Section 69, Station 23 + 0 to Station 49 + 69, New Mystic sewer, North Metropolitan System in Winchester.	4	61,365 75	53,616 00 ²	The Henry Spinach Contracting Co., Waterbury, Conn.
3 112 ¹	Section 57A, Revere extension, North Metropolitan System in Chelsea and Revere.	8	3,363 70	3,360 00 ²	G. M. Bryne Co., Boston.
4 114 ¹	425 tons of coal for Alewife Brook pumping station.	1	-	\$5.15 per ton. ³	Locke Coal Company, Malden.
5 115 ¹	6,900 tons of coal:— 2,700 tons for Deer Island pumping station. 3,000 tons for East Boston pumping station. 1,200 tons for Charlestown pumping station.	2 3 2	\$4.63 per ton. \$4.51 per ton. \$4.53 per ton.	\$3.98 per ton. ³ \$3.98 per ton. ³ \$4.24 per ton. ³	Gorman-Leonard Coal Co., Boston.
6 121 ¹	New screen-house at East Boston pumping station.	7	\$7,867 00	\$7,200 00 ²	J. Caddigan Company, Boston.
7 127	425 tons of coal for Alewife Brook pumping station.	1	-	\$5.15 per ton. ³	Locke Coal Company, Malden.
8 128	1,200 tons of coal for Charlestown pumping station.	1	-	\$4.53 per ton. ³	Metropolitan Coal Company, Boston.
9 129	5,700 tons of coal:— 2,700 tons of coal for Deer Island pumping station. 3,000 tons of coal for East Boston pumping station.	2 3	\$4.58 per ton. \$4.47 per ton.	\$4.20 per ton. ³ \$4.20 per ton. ³	New England Coal & Coke Company, Boston.
10 130	Cast-iron pipes and special castings for Section 1, Deer Island outfall extension, North Metropolitan System, Deer Island, Boston Harbor.	4	\$18,150 00	\$16,735 00 ²	United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa.

¹ Contract completed.

APPENDIX No. 5.

THE YEAR 1915 — SEWERAGE WORKS.

North Metropolitan System.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1915.	10. Value of Work done Dec. 31, 1915.	
Jan. 2, 1914	Nov. 7, 1914	-	\$37,853 18	1
Jan. 2, 1914	Dec. 19, 1914	-	55,638 45	2
May 12, 1914	July 10, 1914	-	3,163 63	3
June 26, 1914	July 1, 1915	-	1,641 99	4
June 26, 1914	July 1, 1915	-	25,477 91	5
Oct. 1, 1914	Mar. 12, 1915	-	7,224 37	6
June 10, 1915	-	\$5.15 per ton of 2,240 pounds delivered in bins at Alewife Brook pumping station.	716 52	7
June 10, 1915	-	\$4.53 per ton of 2,240 pounds delivered in bins at Charlestown pumping station.	1,313 70	8
June 11, 1915	-	\$4.20 per ton of 2,240 pounds delivered in bins at Deer Island pumping station. \$4.20 per ton of 2,240 pounds delivered in bins at East Boston pumping station.	7,579 10	9
Aug. 27, 1915	-	For 84-inch straight pipe, \$37.50 per ton of 2,000 pounds; for special castings, \$74 per ton of 2,000 pounds.	-	10

^a Contract based upon this bid.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

1. Number of Contract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Lowest.	5. Lowest.	
11 131	Section 1A Deer Island outfall extension, temporary outfall sewer, North Metropolitan System, Deer Island, Boston Harbor.	5	\$44,358 75	\$43,370 00 ²	George M. Bryne, Boston.
12 132	Section 19, Reconstruction in new location of Malden River siphon, North Metropolitan System in Everett and Medford.	4	29,110 00	26,000 00 ²	George M. Bryne, Boston.

Contracts relating to the

1. Number of Contract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Lowest.	5. Lowest.	
1 116 ¹	2,650 tons of coal:— 2,200 tons for Ward Street pumping station. 450 tons for Nut Island screen-house.	2	\$5.15 per ton. \$4.79 per ton.	\$4.85 per ton. ² \$4.35 per ton. ²	Gorman-Leonard Coal Co., Boston.
2 117 ¹	450 tons of coal for Quincy pumping station.	2	\$4.08 per ton.	\$4.80 per ton. ²	Frost Coal Company, Boston.
3 120	Section 43, Relief outfall, High-level sewer, South Metropolitan System in Quincy.	8	\$36,310 00	\$34,790 00 ²	W. H. Ellis & Son Co., East Boston.
4 122 ¹	Section 70, Siphon crossing, High-level sewer, South Metropolitan System in West Roxbury.	4	5,250 00	4,500 00 ²	Charles A. Haskin, Charlestown.
5 123	Section 106, High-level sewer, Wellesley extension, South Metropolitan System in Needham and Wellesley.	7	37,651 00	27,912 50 ²	Hugh Nawn Contracting Company, Boston.

¹ Contract completed.

THE YEAR 1915—SEWERAGE WORKS—Continued.

North Metropolitan System—Concluded.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1915.	10. Value of Work done Dec. 31, 1915.	
Oct. 11, 1915	-	For earth excavation and refilling in trench for 78-inch concrete outfall sewer, \$18 per lin. ft.; for earth excavation, laying and refilling in trench for 60-inch cast-iron outfall pipes, \$40 per lin. ft.; for Portland cement brick masonry in manholes and special structures, \$20 per cu. yd.; for Portland cement concrete masonry in trench and special structures, \$8 per cu. yd.	\$2,354 50	11
Nov. 16, 1915	-	For earth excavation and refilling in trench, Everett side, for 60-inch and 48-inch masonry sewers, \$18 per lin. ft.; for earth excavation and refilling in trench, Medford side, for 48-inch masonry sewer, \$14 per lin. ft.; for earth excavation and refilling in air tunnel and shaft for 48-inch masonry sewer, \$45 per lin. ft.; for Portland cement brick masonry in trench, manholes and special structures, \$16 per cu. yd.; for Portland cement brick masonry in tunnel and shaft, \$16 per cu. yd.; for Portland cement concrete masonry in trench, manholes and special structures, \$9 per cu. yd.; for Portland cement concrete masonry in tunnel and shaft, \$9 per cu. yd.; for spruce piles in place in trench, \$0.40 per lin. ft.; for spruce piles in place in air tunnel, \$0.40 per lin. ft.	-	12

South Metropolitan System.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1915.	10. Value of Work done Dec. 31, 1915.	
June 26, 1914	July 1, 1915	-	\$13,743 65	1
June 26, 1914	July 1, 1915	-	1,734 67	2
Aug. 29, 1914	Dec. 1, 1915	-	29,783 16	3
Nov. 21, 1914	Jan. 11, 1915	-	4,500 00	4
July 29, 1915	-	For earth excavation and refilling in trench and embankment for 24-in. by 27-in. concrete sewer, \$2.75 per lin. ft.; for earth or rock excavation in tunnel for 24-in. by 27-in. concrete sewer, \$6 per lin. ft.; for Portland cement brick masonry in manholes and special structures, \$18 per cu. yd.; for Portland cement concrete masonry in trench and special structures, \$7.50 per cu. yd.; for Portland cement concrete masonry in tunnel, \$10 per cu. yd.	14,994 21	5

¹ Contract based upon this bid.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

1. Number of Contract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Lowest.	5. Lowest.	
6 124	Section 105, High-level sewer, Wellesley extension, South Metropolitan System in Needham.	7	\$37,272 50	\$29,655 00 ^a	Hugh Nawn Contracting Company, Boston.
7 125	450 tons of coal for Quincy pumping station.	2	\$5.20 per ton.	\$4.99 per ton. ^a	Frost Coal Company, Boston.
8 126	2,300 tons of coal for Ward Street pumping station.	2	\$5.05 per ton.	\$4.93 per ton. ^a	Staples Coal Company, Boston.
9 127	550 tons of coal for Nut Island screen-house.	1	-	\$4.75 per ton. ^a	Metropolitan Coal Company, Boston.
10 133	Section 104, High-level sewer, Wellesley extension, South Metropolitan System in Needham.	8	\$64,272 50	\$59,055 00 ^a	Bay State Dredging and Contracting Company, Boston.
11 134	Section 103, High-level sewer, Wellesley extension, South Metropolitan System in Needham.	12	\$5,312 00	\$4,011 00 ^a	Bruno and Petitti, Boston.

^a Contract based upon this bid.

THE YEAR 1915—SEWERAGE WORKS—*Concluded.**South Metropolitan System*—Concluded.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1915.	10. Value of Work done Dec. 31, 1915.	
July 29, 1915	-	For earth excavation and refilling in trench and embankment for 24-in. by 27-in. concrete sewer, \$3 per lin. ft.; for Portland cement brick masonry in manholes and special structures, \$18 per cu. yd.; for Portland cement concrete masonry in trench and special structures, \$7.50 per cu. yd.; for rock excavation in trench, \$3 per cu. yd.	\$29,474 71	6
June 9, 1915	-	\$4.99 per ton of 2,240 pounds delivered in bins at Quincy pumping station.	345 72	7
June 9, 1915	-	\$4.03 per ton of 2,240 pounds delivered in bins at Ward Street pumping station.	3,510 96	8
June 10, 1915	-	\$4.75 per ton of 2,240 pounds delivered on wharf at Nut Island screen-house.	1,083 00	9
Dec. 22, 1915	-	For earth excavation and refilling in trench and embankment for 24-in. by 27-in. and 27-in. by 36-in. concrete sewer, \$4.25 per lin. ft.; for earth or rock excavation or both and refilling in tunnel for 27-in. by 36-in. concrete sewer, \$10.25 per lin. ft.; for Portland cement brick masonry in manholes and special structures, \$18 per cu. yd.; for Portland cement concrete masonry in trench and special structures, \$8.50 per cu. yd.; for Portland cement concrete masonry in tunnel, \$10.60 per cu. yd.; for rock excavation in trench, \$5.50 per cu. yd.	-	10
Dec. 22, 1915	-	For earth excavation and refilling in trench and embankment for 24-in. by 27-in. concrete sewer, \$2.25 per lin. ft.; for Portland cement brick masonry in manholes and special structures, \$15 per cu. yd.; for Portland cement concrete masonry in trench and special structures, \$7.50 per cu. yd.; for rock excavation in trench, \$3 per cu. yd.	-	11

CONTRACTS MADE AND PENDING DURING THE YEAR 1915—SEWERAGE WORKS
—Concluded.

Summary of Contracts.

	Value of Work done Dec. 31, 1915.
North Metropolitan System, 12 contracts,	\$142,963 35
South Metropolitan System, 11 contracts,	99,170 08
Total of 23 contracts made and pending during the year 1915,	<u>\$242,133 43</u>

APPENDIX No. 6.

FINANCIAL STATEMENT PRESENTED TO THE GENERAL COURT
ON JANUARY 17, 1916.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its receipts, expenditures, disbursements, assets and liabilities for the year ending November 30, 1915, together with recommendations for legislation which it deems desirable, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

METROPOLITAN WATER WORKS.

Construction.

The loans authorized for expenditures under the Metropolitan Water acts, the receipts which are added to the loan fund, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1915, have been as follows:—

Loans authorized under Metropolitan Water acts,	\$42,798,000 00
Receipt from town of Swampscott for admission to Metropolitan Water District, paid into Loan Fund (St. 1909, c. 320),	90,000 00
Receipts from the sales of property which are placed to the credit of the Metropolitan Water Loan Fund:—	
For the year ending November 30, 1915,	\$1,792 16
For the period prior to December 1, 1914,	242,911 42
	<hr/>
	244,703 38
	<hr/>
	\$43,132,703 38

Amount approved for payment by the Board out of the Metropolitan Water Loan Fund:—

For the year ending November 30, 1915,	\$409,598 46
For the period prior to December 1, 1914,	42,386,391 43
	<hr/>
	42,795,989 89
Balance December 1, 1915,	<hr/>
	\$336,713 49

The amount of the Metropolitan Water Loan bonds issued at the end of the fiscal year was \$42,536,000, bonds to the amount of \$490,000 having been issued during the year. Of the amount issued, \$41,398,000 were sinking fund bonds, and the remainder, amounting to \$1,138,000, were issued as serial bonds.

At the end of the year the amount of the outstanding bonds was \$42,494,000, as bonds issued on the serial payment plan to the amount of \$42,000 had been paid. During the fiscal year \$17,000 in serial bonds has been paid.

The Metropolitan Water Loan Sinking Fund amounted on December 1, 1915, to \$12,491,245.25, an increase during the year of \$957,791.80.

The net debt on December 1, 1915, was \$30,002,754.75, a decrease during the fiscal year of \$484,791.80.

Maintenance.

Amount appropriated for the maintenance and operation of works, for the year ending November 30, 1915,	\$460,835 00
Special appropriation (chapter 369, Acts of 1915),	115 00
Special appropriation for protection of water supply in aqueducts (1911) remaining,	9,930 60
Special appropriations for protection and improvement of the water supply (1912 and 1913) remaining,	35,143 37
Receipts credited to this fund for the year ending November 30, 1915,	43,326 13
	<hr/>
Amount approved by Board for maintenance and operation of works during year ending November 30, 1915,	\$549,350 10
Balance December 1, 1915,	436,129 64
	<hr/>
Balance December 1, 1915,	\$113,220 46

This balance includes the sum of \$9,930.60, the amount remaining unexpended of the special appropriation for the protection of the water supply in aqueducts, and the sums of \$2,713.93, the amount remaining unexpended of the special appropriation in 1912, and \$1,874.38, of the special appropriation in 1913 for the protection and improvement of the water supply.

The Board has also received during the year ending November 30, 1915, \$43,326.13 from rentals, the sale of land, land products and power and from other proceeds from the operations of the Board, which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works, in reduction of the amount to be assessed upon the Metropolitan Water District for the year.

Sums received from sales of water to municipalities not belonging to the District and to water companies, and from municipalities for admission to the District, have been applied as follows:—

For the period prior to December 1, 1906, distributed to the cities and towns of the District, as provided by section 3 of the Metropolitan Water Act,	\$219,865 65
For the period beginning December 1, 1906, and prior to December 1, 1914, applied to the Metropolitan Water Loan Sinking Fund, as provided by chapter 238 of the Acts of 1907,	51,569 11
For the year beginning December 1, 1914, and ending November 30, 1915, applied to the Metropolitan Water Loan Sinking Fund, as provided by said last-named act,	14,075 77
	\$285,510 53

METROPOLITAN SEWERAGE WORKS.

Construction.

The loans authorized under the various acts of the Legislature for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of the loans, and the expenditures for construction, are given below, as follows:—

North Metropolitan System.

Loans authorized for expenditures for construction under the various acts, including those for the Revere, Belmont and Malden extensions, North System enlargements and extensions, New Mystic sewer, Deer Island outfall extension, lowering sewer siphon under Malden River and balance of appropriation under chapter 215, Acts of 1915, . . .	\$7,227,365 73
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System:—	
For the year ending November 30, 1915,	153 27
For the period prior to December 1, 1914,	85,363 52
Amount approved for payment by the Board ¹ out of the Metropolitan Sewerage Loan Fund, North System:—	
For the year ending November 30, 1915,	\$37,249 63
For the period prior to December 1, 1914,	7,084,383 48
\$7,312,882 52	\$7,121,633 11
Balance December 1, 1915,	\$191,249 41

¹ The word "Board" refers to the Metropolitan Sewerage Commission and its successor, the Metropolitan Water and Sewerage Board.

South Metropolitan System.

Loans authorized for expenditures for construction under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extensions (including Wellesley branch), and an additional appropriation authorized by chapter 210, Acts of 1915, \$9,222,046 27

Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System:—

For the year ending November 30, 1915, 4,972 24

For the period prior to December 1, 1914, 14,092 01

Amount approved by the Board for payment as follows:—

On account of the Charles River valley sewer, \$800,046 27

On account of the Neponset valley sewer, 911,531 46

On account of the High-level sewer and extensions:—

For the year ending November 30, 1915, 72,447 38

For the period prior to December 1, 1914, 7,139,151 99

\$9,241,110 52 \$8,923,177 10

Balance December 1, 1915, \$317,933 42

The amount of the Metropolitan Sewerage Loan bonds issued at the end of the fiscal year was \$16,011,412, bonds to the amount of \$130,500 having been issued during the year. Of the amount issued, \$15,440,912 were sinking fund bonds, and the remainder, amounting to \$570,500, were serial bonds.

At the end of the year the amount of the outstanding bonds was \$15,982,412, as bonds issued on the serial payment plan to the amount of \$13,000 had been paid during the year, \$29,000 having been paid to December 1, 1915.

Of the total amount outstanding at the end of the year, \$7,104,500 were issued for the North Metropolitan System and \$8,877,912 for the South Metropolitan System. The Metropolitan Sewerage Loan Sinking Fund amounted on December 1, 1915, to \$3,290,979.46, of

which \$2,095,509.86 was on account of the North Metropolitan System and \$1,195,469.60 was on account of the South Metropolitan System, an increase during the year of \$279,467.02.

The net debt on December 1, 1915, was \$12,691,432.54, a decrease of \$161,967.02.

Included in the above figures for the North Metropolitan System is \$570,500 in serial bonds issued under chapter 512 of the Acts of 1911, of which \$29,000 has been paid.

Maintenance.

North Metropolitan System.

Appropriated for the year ending November 30, 1915,	. . . . .	\$186,000 00
Portion of appropriation under chapter 775, Acts of 1914,	. . . . .	10,569 06
		<hr/>
		\$196,569 06

Receipts from pumping and from other sources, which are returned to the appropriation:—

For the year ending November 30, 1915,	. . . . .	568 97
		<hr/>
		\$197,138 03

Amount approved for payment by the Board:—

For the year ending November 30, 1915,	. . . . .	179,177 60
		<hr/>

Balance December 1, 1915, \$17,960 43

South Metropolitan System.

Appropriated for the year ending November 30, 1915,	. . . . .	\$117,855 00
Receipts from sales of property and for pumping, which are returned to the appropriation:—		
For the year ending November 30, 1915,	. . . . .	145 28

		<hr/>
Amount approved for payment by the Board:—		
For the year ending November 30, 1915,	. . . . .	108,060 86
		<hr/>

Balance December 1, 1915, \$9,939 42

APPENDIX No. 7.

LEGISLATION OF THE YEAR 1915 AFFECTING THE METROPOLITAN WATER AND SEWERAGE BOARD.

General Acts, 1915.

CHAPTER 75.

AN ACT RELATIVE TO THE WEEKLY PAYMENT OF WAGES.

Be it enacted, etc., as follows:

1909, 514, § 112,
etc., amended.

Weekly pay-
ment of
wages, etc.

SECTION 1. Section one hundred and twelve of chapter five hundred and fourteen of the acts of the year nineteen hundred and nine, as amended by chapter three hundred and fifty of the acts of the year nineteen hundred and ten, by chapter two hundred and eight of the acts of the year nineteen hundred and eleven, by chapter seven hundred and eighty-four of the acts of the year nineteen hundred and thirteen, and by chapter two hundred and forty-seven of the acts of the year nineteen hundred and fourteen, is hereby further amended by striking out the words "or any of the building trades", in the fifth line, and inserting in place thereof the words: — or in the erection, alteration, repair or removal of any building or structure, — so as to read as follows: — *Section 112.* Every person, firm or corporation engaged in carrying on a factory, workshop, manufacturing, mechanical or mercantile establishment, mine, quarry, railroad or street railway, or a telephone, telegraph, express or water company, or in the erection, alteration, repair or removal of any building or structure, or the construction or repair of any railroad, street railway, road, bridge, sewer, gas, water or electric light works, pipes or lines, shall pay weekly each employee engaged in his or its business the wages earned by him to within six days of the date of said payment, but any employee leaving his or her employment, shall be paid in full on the following regular pay day; and any employee discharged from such employment shall be paid in full on the day of his discharge, or in the city of Boston as soon as the provisions of law requiring pay rolls, bills and accounts to be certified shall

have been complied with; and the commonwealth, its officers, boards and commissions shall so pay every mechanic, workman and laborer who is employed by it or them, and every person employed by it or them in any penal or charitable institution, and every county and city shall so pay every employee who is engaged in its business the wages or salary earned by him, unless such mechanic, workman, laborer or employee requests in writing to be paid in a different manner; and every town shall so pay each employee in its business if so required by him; but an employee who is absent from his regular place of labor at a time fixed for payment shall be paid thereafter on demand. The provisions of this section shall not apply to an Exemptions. employee of a co-operative corporation or association if he is a stockholder therein unless he requests such corporation to pay him weekly. The public service commission, after a hearing, may exempt any railroad corporation from paying weekly any of its employees if it appears to the board that such employees prefer less frequent payments, and that their interests and the interests of the public will not suffer thereby. No corporation, contractor, person or partnership shall by a special contract with an employee or by any other means exempt himself or itself from the provisions of this and the following section. Whoever violates the pro- Penalty. visions of this section shall be punished by a fine of not less than ten nor more than fifty dollars.

SECTION 2. This act shall take effect upon its passage.
[Approved March 17, 1915.]

CHAPTER 95.

AN ACT RELATIVE TO THE RETIREMENT OF CERTAIN VETERANS IN THE SERVICE OF THE COMMONWEALTH.

Be it enacted, etc., as follows:

Section one of chapter four hundred and fifty-eight of 1907, 458, § 1, the acts of the year nineteen hundred and seven is hereby amended by inserting after the word "war", in the tenth line, the words: — after five years, — and by striking out the words "at any time", in the twelfth and thirteenth lines, so as to read as follows: — *Section 1.* A veteran of the civil war in the service of the commonwealth, if incapacitated for active duty, shall be retired from active service, with the consent of the governor, at one half the rate of

Retirement of
certain vet-
erans in serv-
ice of the
common-
wealth.

Proviso.

compensation paid to him when in active service, to be paid out of the treasury of the commonwealth: *provided*, that no veteran shall be entitled to be retired under the provisions of this act unless he shall have been in the service of the commonwealth at least ten years. But if, in the opinion of the governor and council, any veteran of the civil war, after five years, in said service is incapacitated to such a degree as to render his retirement necessary for the good of the service, he may so be retired. A veteran retired under the provisions of this act, whose term of service was for a fixed number of years, shall be entitled to the benefits of the act without reappointment. [Approved March 23, 1915.]

CHAPTER 147.

AN ACT TO PROVIDE FOR ADDITIONAL REGULATION RELATIVE TO THE INTRODUCTION OF SEWAGE INTO THE SOUTH METROPOLITAN SEWERAGE SYSTEM.

Be it enacted, etc., as follows:

1899, 424, § 8,
amended.

Proviso.

SECTION 1. Section eight of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine is hereby amended by striking out the word "and" where it first occurs, in the fifth line, and inserting after the word "control", in the same line, the words: — and regulation, — so as to read as follows: — *Section 8.* Any city or town, within the limits of which any main sewer shall have been constructed under the provisions of this act, shall connect its local sewers with such main sewer, except as hereinafter provided, subject to the direction, control and regulation of said board, and any person, firm or corporation may, subject to the direction, control and regulation, from time to time, of said board, and subject to such terms, conditions and regulations as each city or town may prescribe, connect private drains with such main sewer: *provided*, that the said board shall, without expense to the city of Quincy, make all connections and take and construct such intercepting sewers as may be necessary to enable the city of Quincy to drain by gravity its territory into said metropolitan sewer. The present pumping station and force mains of the city of Quincy shall be taken and paid for by said board of metropolitan sewerage commissioners, and said board shall build and operate such new force main or mains and pumping stations as may be neces-

sary to enable the city of Quincy to drain its sewerage systems into said metropolitan sewer. The sewerage systems of all drainage areas not now drained by the south metropolitan system, which are constructed after the passage of this act, shall be constructed in accordance with the so-called separate system of sewerage.

SECTION 2. This act shall take effect upon its passage.
[Approved April 8, 1915.]

CHAPTER 150.

AN ACT TO PROVIDE FOR ADDITIONAL REGULATION RELATIVE TO THE INTRODUCTION OF SEWAGE INTO THE NORTH METROPOLITAN SEWERAGE SYSTEM.

Be it enacted, etc., as follows:

SECTION 1. Section nine of chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine is hereby amended by striking out the word "and", in the fourth line, and inserting after the word "control", in the same line, the words: — and regulation, — so as to read as follows: — *Section 9.* Any city or town within whose limits any main sewer shall have been constructed under the provisions of this act shall connect its local sewers with such main sewer, subject to the direction, control and regulation of said board, and any person, firm or corporation may, subject to the direction, control and regulation from time to time of said board, and subject to such terms, conditions and regulations as each city or town may prescribe, connect private drains with said main sewer.

SECTION 2. This act shall take effect upon its passage.
[Approved April 8, 1915.]

CHAPTER 210.

AN ACT TO PROVIDE FOR AN ADDITIONAL OUTLET FOR THE SOUTH METROPOLITAN SEWER.

Be it enacted, etc., as follows:

SECTION 1. For the purpose of meeting the expenses incurred by the metropolitan water and sewerage board in providing an additional outlet for the south metropolitan sewer at Nut Island, Quincy, as authorized by chapter four hundred and twenty-four of the acts of the year eight-

Additional
outlet for the
south metro-
politan sewer.

**Metropolitan
Sewerage Loan.**

teen hundred and ninety-nine, the treasurer and receiver general shall issue from time to time, in the name and behalf of the commonwealth and under its seal, bonds designated on the face thereof, Metropolitan Sewerage Loan, to an amount not exceeding five thousand dollars, in addition to the amount of such bonds heretofore authorized for the construction of the south metropolitan sewerage works.

**Certain pro-
visions of law
to apply.**

SECTION 2. The provisions of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine and of all acts in amendment thereof and in addition thereto shall, so far as they may be applicable, apply to the indebtedness authorized by this act and to all proceedings hereunder.

SECTION 3. This act shall take effect upon its passage.
[Approved April 28, 1915.]

CHAPTER 215.

AN ACT ACCEPTING CERTAIN CONDITIONS RELATIVE TO THE
IMPROVEMENT OF MALDEN RIVER.

Be it enacted, etc., as follows:

**Certain condi-
tions to be
accepted by
the com-
mon-
wealth
relative to the im-
provement of
Malden river.**

SECTION 1. The conditions set forth in the act of congress, known as the River and Harbor bill, approved July twenty-fifth, nineteen hundred and twelve, and in acts in addition thereto and in amendment thereof, which require that the sum appropriated, or to be made available, by congress by said acts, for completing the improvement in Malden river in this commonwealth, shall not be expended until the commonwealth has lowered the siphon of the metropolitan sewer which now crosses said river, and shall have pledged itself for all cost of maintenance of the new depth of the channel, are hereby accepted; and the metropolitan water and sewerage board is hereby authorized and directed to lower the said siphon and to do any other act or thing necessary to comply with the requirements of the said acts, and may expend for this purpose a sum not exceeding seventy thousand dollars.

**Metropolitan
Sewerage
Loan.**

SECTION 2. To meet the expenses incurred under the provisions of this act the treasurer and receiver general shall issue from time to time in the name and behalf of the commonwealth and under its seal, bonds designated on the face thereof, Metropolitan Sewerage Loan, to an amount not exceeding seventy thousand dollars, in addition to the

amount of such bonds heretofore authorized for the construction of the north metropolitan sewerage works.

SECTION 3. The provisions of chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and of all acts in amendment thereof and in addition thereto shall, so far as they may be applicable, apply to the indebtedness authorized by this act and to all proceedings hereunder.

SECTION 4. This act shall take effect upon its passage.
[Approved April 29, 1915.]

Certain provisions of law to apply.

CHAPTER 244.

AN ACT TO FIX RESPONSIBILITY FOR THE PAYMENT OF WORKMEN'S COMPENSATION BY THE COMMONWEALTH AND BY COUNTIES, CITIES, TOWNS AND DISTRICTS.

Be it enacted, etc., as follows:

SECTION 1. Every board, commission and department of the commonwealth employing laborers, workmen and mechanics, the Boston transit commission, and every county, city, town and district which has accepted the provisions of chapter eight hundred and seven of the acts of the year nineteen hundred and thirteen shall, through its executive officer or board, designate a person to act as its agent in furnishing the benefits due under chapter seven hundred and fifty-one of the acts of the year nineteen hundred and eleven and acts in amendment thereof and in addition thereto. Such agent shall be held responsible for the proper carrying out of this act under the direction and supervision of the industrial accident board until his agency is revoked and a new agent designated. The name and address of every such agent shall be filed with the industrial accident board immediately upon his designation; and each of the foregoing boards, commissions, departments, counties, cities, towns and districts shall designate such an agent within thirty days after this act takes effect.

Agents to carry out provisions of workmen's compensation act.

SECTION 2. This act shall not apply to counties, cities, towns and districts which are insured under the provisions of chapter seven hundred and fifty-one of the acts of the year nineteen hundred and eleven and acts in amendment thereof.

Not to apply to certain counties, cities, towns, etc.

SECTION 3. This act shall take effect on the first day of June, in the year nineteen hundred and fifteen. [Approved May 10, 1915.]

Time of taking effect.

CHAPTER 251.

AN ACT RELATIVE TO REMOVALS, SUSPENSIONS AND TRANSFERS IN THE CIVIL SERVICE.

*Be it enacted, etc., as follows:*1911, 624, § 1,
amended.Removals,
suspensions
and transfers
in civil service.Action of
officer or
board, etc.,
may be re-
viewed by
court.Decision to be
final.

Section one of chapter six hundred and twenty-four of the acts of the year nineteen hundred and eleven is hereby amended by striking out the word "ten", in the fourteenth line, and inserting in place thereof the word: — thirty, — and by striking out the word "the", in the twenty-second line, and inserting in place thereof the word: — any, — so as to read as follows: — *Section 1.* Every person now holding or hereafter appointed to an office classified under the civil service rules of the commonwealth, except members of the police department of the city of Boston, of the police department of the metropolitan park commission, and except members of the district police, whether appointed for a definite or stated term, or otherwise, who is removed therefrom, lowered in rank or compensation, or suspended, or, without his consent, transferred from such office or employment to any other, may, after a public hearing, as provided for by section two of chapter three hundred and fourteen of the acts of the year nineteen hundred and four, as amended by chapter two hundred and forty-three of the acts of the year nineteen hundred and five, and within thirty days after such hearing, bring a petition in the police, district or municipal court within the judicial district where such person resides, addressed to the justice of the court and praying that the action of the officer or board in removing, suspending, lowering or transferring him may be reviewed by the court, and after such notice to such officer or board as the court may think necessary, it shall review the action of said officer or board, and hear any witnesses, and shall affirm said order unless it shall appear that said order was made by said officer or board without proper cause or in bad faith, in which case said order shall be reversed and the petitioner be reinstated in his office. The decision of the justice of said police, district or municipal court shall be final and conclusive upon the parties. [Approved May 11, 1915.]

Special Acts, 1915.**CHAPTER 156.****AN ACT MAKING AN APPROPRIATION FOR MAINTAINING
AND OPERATING THE SOUTH METROPOLITAN SEWER-
AGE SYSTEM.**

Be it enacted, etc., as follows:

SECTION 1. A sum not exceeding one hundred seventeen thousand eight hundred and fifty-five dollars is hereby appropriated, to be paid out of the South Metropolitan Sewerage System Maintenance Fund, for the cost of maintenance and operation of the south metropolitan sewerage system, comprising a part of Boston, the cities of Newton and Waltham, and towns of Brookline, Watertown, Dedham and Milton, during the fiscal year ending on the thirtieth day of November, nineteen hundred and fifteen.

South metropolitan sewerage system, maintenance.

SECTION 2. This act shall take effect upon its passage.

[Approved March 10, 1915.]

CHAPTER 157.**AN ACT MAKING AN APPROPRIATION FOR MAINTAINING
AND OPERATING THE NORTH METROPOLITAN SEWER-
AGE SYSTEM.**

Be it enacted, etc., as follows:

SECTION 1. A sum not exceeding one hundred eighty-five thousand five hundred dollars is hereby appropriated, to be paid out of the North Metropolitan Sewerage System Maintenance Fund, for the maintenance and operation of a system of sewage disposal for the cities included in what is known as the north metropolitan sewerage system, during the fiscal year ending on the thirtieth day of November, nineteen hundred and fifteen.

North metropolitan sewerage system, maintenance.

SECTION 2. This act shall take effect upon its passage.

[Approved March 10, 1915.]

CHAPTER 159.**AN ACT MAKING AN APPROPRIATION FOR MAINTAINING
AND OPERATING THE METROPOLITAN WATER SYSTEM.**

Be it enacted, etc., as follows:

SECTION 1. A sum not exceeding four hundred sixty thousand seven hundred and twenty dollars is hereby ap-

Metropolitan water system, maintenance.

propriated, to be paid out of the Metropolitan Water Maintenance Fund, for the maintenance and operation of the metropolitan water system for the cities and towns in what is known as the metropolitan water district, during the fiscal year ending on the thirtieth day of November, nineteen hundred and fifteen.

SECTION 2. This act shall take effect upon its passage.
[Approved March 10, 1915.]

CHAPTER 369.

AN ACT IN FURTHER ADDITION TO THE ACTS MAKING APPROPRIATIONS FOR SUNDRY MISCELLANEOUS EXPENSES AUTHORIZED DURING THE PRESENT YEAR AND FOR CERTAIN OTHER EXPENSES AUTHORIZED BY LAW.

Be it enacted, etc., as follows:

Appropriations.

SECTION 1. The sums hereinafter mentioned are appropriated, to be paid out of the treasury of the commonwealth from the ordinary revenue, unless otherwise specified, to wit: —

Thomas M.
McGee.

For Thomas M. McGee, in compensation for injuries to his minor son, Paul R. McGee, caused by an automobile operated by an employee of the metropolitan water and sewerage board, the sum of one hundred and fifteen dollars, to be paid from the Metropolitan Water Maintenance Fund.

Dependents
of James
McGovern.

To be expended by the metropolitan water and sewerage board for the benefit of the dependents of James McGovern, as authorized by chapter one hundred and one of the resolves of the present year, the sum of five hundred dollars, to be paid from the Metropolitan Sewerage Maintenance Fund, North System.

CHAPTER 76.

RESOLVE PROVIDING FOR IMPROVEMENTS IN THE NORTH METROPOLITAN SEWERAGE SYSTEM.

Improvements
in north met-
ropolitan sew-
erage system.

Resolved, That the metropolitan water and sewerage board is hereby authorized to use the balance remaining of the amount appropriated for repairing the damage done

by a recent explosion at the metropolitan sewerage pumping station in East Boston for the extension of existing works in the north metropolitan sewerage system and the construction of such new works as the board may deem necessary for the said north system. [Approved April 28, 1915.

CHAPTER 101.

RESOLVE IN FAVOR OF THE FAMILY OF THE LATE JAMES MCGOVERN OF BOSTON.

Resolved, That the metropolitan water and sewerage board is hereby authorized to pay to the dependents of the late James McGovern of Boston the sum of five hundred dollars, in compensation for injuries sustained by him by an explosion which occurred at the East Boston pumping station on June first, in the year nineteen hundred and fourteen, and from the effects of which he has since died. The payments shall be made from the North Metropolitan Sewerage Fund. Chapter one hundred and fifty-four of the resolves of the year nineteen hundred and fourteen is hereby repealed. [Approved May 17, 1915.

CHAPTER 128.

RESOLVE PROVIDING FOR THE PAYMENT BY THE COMMONWEALTH OF A SUM OF MONEY TO JOSEPH HANREDDY.

Resolved, That the metropolitan water and sewerage board be authorized and directed to make such settlement of the claim of Joseph Hanreddy for compensation for money spent and expenses incurred by him in connection with various suits brought against him in the performance of a contract for constructing a pressure tunnel and laying a pipe line in section seven of the Weston aqueduct supply mains in the city of Newton, as appears to them just and equitable, at an expense not exceeding ten thousand dollars, to be paid from the Metropolitan Water Loan Fund, and the treasurer and receiver general is hereby authorized to borrow upon the credit of the commonwealth, under the provisions of the general or special laws relative to the loans for metropolitan water construction, such sums, not exceeding ten thousand dollars, as the metropolitan water and sewerage board deem necessary. [Approved May 27, 1915.

CHAPTER 137.

RESOLVE PROVIDING FOR AN INVESTIGATION RELATIVE TO THE HOURS OF LABOR OF PUBLIC EMPLOYEES AND RELATIVE TO SATURDAY HALF-HOLIDAYS FOR LABORERS, WORKMEN AND MECHANICS EMPLOYED BY OR ON BEHALF OF THE COMMONWEALTH.

Investigation
as to hours of
labor of public
employees,
Saturday half-
holidays, etc.

Resolved, That the subject-matter contained in the bill relative to the hours of labor of public employees, printed as House Document No. 397, and in the bill relative to Saturday half-holidays for laborers, workmen and mechanics employed by or on behalf of the commonwealth, printed as House Document No. 2140, both of the current year, be referred to the commission on economy and efficiency for investigation. Said commission shall report the results of its investigation, together with such recommendations as it may deem advisable, to the next general court on or before the second Wednesday in January. [Approved May 28, 1915.]

